BRAIN.

PART IV., 1891.

Original Articles.

TWO CASES OF GENERAL CUTANEOUS AND SENSORY ANÆSTHESIA, WITHOUT MARKED PSYCHICAL IMPLICATION.

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WHILE in certain forms of hysteria, melancholia, and alcoholism, passing or even continued disturbance of sensation, both of the cutaneous surfaces and special senses is by no means uncommon, profound and widespread anæsthesias without pronounced psychical alteration, belong to the most rare of all the forms of nervous disturbance.

To the few observations now existing in medical literature I desire to add two new cases that occurred in the wards of the City Asylum during my service there in the summer of 1890.

CASE I.—Mrs. R., an Englishwoman, was admitted to the Hospital Department in July, 1890, with a general disturbance of cutaneous sensation.

Family History.—The father of the patient died at an early age of consumption. At the age of seventy-four the mother was sent to an insane asylum, where she died a year afterwards (senile dementia?). Two maternal uncles, as well as two brothers and two sisters, have been confined at various times in asylums in England, but the form of mental alienation is unknown to the patient.

Mrs. R. was married early in life, and became the mother of five children, three of whom are living, and

reported as being in good health. According to her own story, after she had been married for some years her husband became dissipated in his habits, and at the age of twenty-nine she contracted syphilis from him. After this event she had several abortions in succession, as well as some sore-throat and falling out of the hair.

From this time until six years ago she enjoyed fairly good health; then came an attack of acute articular rheumatism, with much joint swelling and pain. From this attack the general health never fully recovered, though there was no recurrence of the arthritis, or joint deformity. Several months later the eyesight gradually began to grow dim, and there were occasional flashes of light before the eyes; then vision was suddenly completely lost, returning in part after a few days, and was then finally and gradually extinguished. At this period she also suffered a recurrence of the sore throat, which lasted some weeks.

Her health then returned to its usual state until the Christmas of 1889, when she became troubled with a general tingling and formication of the skin of the entire body, but especially troublesome in the fore-arms and calves of the legs. These paræsthesias were soon in great measure lost, and beyond a certain inability to feel or hold objects in the hands, she was no longer disturbed.

In the first week of the year 1890, the patient had an attack of emesis, which continued through several weeks. The vomiting was incessant, and was uninfluenced by any of the ordinary remedies. Very little or no pain was present during the attack, which from the attendant physician's report seems to have been solely of a reflex nature. Periods of emesis of the same kind have been repeated at irregular intervals to the present date, gradually lessening in severity and duration.

Present State.—Mrs. R. is a slightly built, rather well developed woman of medium height. The cranium is small, but perfectly symmetrical. The hair is thin, patchy. The skin over the entire body is well nourished, yellowish in hue. The facial muscles are firm, reacting normally to the will and to faradism. The ocular muscles are perfect in

their action. Those of the extremities are small, and their strength is very moderate; the hand grip is quite weak. Dynamometer R. and L., 50. There are no trophic lesions about the nails of the hands and feet.

Examination of the thorax and abdomen gave a negative result. The heart's action is normal, a little rapid—85 to the minute; tonus fair. Arteries a little thickened.

The appetite is very poor, desire for food being almost extinct. Thirst is not great. The urine contained neither albumen nor sugar, on repeated tests.

The eyesight is reduced to the perception of the difference between light and darkness in the left eye, in the right there is absolute blindness. The surface of the eye-balls and conjunctival sacs is not quite, but very nearly dry. The conjunctivæ are very slightly reddened. Both pupils are in a state of mid-dilatation, and respond very feebly to light, direct or reflected. There is no response on irritation of the skin of the neck. Headache is not complained of.

Hearing is normal, both for the voice, and for high and low pitched tones. A low ticking watch is heard at the distance of 36 cm. by both ears, also distinctly through the cranial bones.

Ammonia, iodoform, essential oils, camphor, &c., are not recognised with either nostril. Both nares and turbinated bones are dry and injected.

The buccal cavity is extremely dry, the tongue heavily furred on its dorsum, and exceedingly cracked; the epithelium is eroded from the tip and sides. The buccal mucous surfaces are red and congested. The orifices of the submaxillary ducts are raised above the surface and reddened. No secretion can be seen to escape from these ducts, and but little seems to come from the parotid. The velum palati is injected, and does not retract when irritated. There is no faucial or pharyngeal reflex, and no sensation of nausea, or act of coughing is produced when the fauces are titillated, or even when a brush is carried down over the epiglottis; yet no accident has occurred during the ingestion of food. Articulation is made somewhat thick by the dryness of the tongue and buccal cavity, but each word is enunciated clearly.

Salt and sugar solutions pencilled over the tongue, hard palate, uvula, and arches, are not perceived; over the epiglottis there seems to be some sensation. Quinine is nowhere perceived, neither are acids. With a constant current of two to three cells the result is also negative; the whole tongue, hard and soft palates, arches, back of pharynx, &c., were successively gone over without eliciting any result. There is even no sensation when the electrodes are carried behind the uvula, high into the posterior nares and pharynx.

There is absolute loss of sensation for heat, cold, pain, almost absolute for tactile and pressure sensations over the whole of the cephalic, superior extremities, trunk, and inferior extremities, with the exception of a portion of the soles of the feet. The corneæ and eye-balls may be roughly rubbed, the nose titillated with a feather, the point of a pin inserted in the tongue or finger-tips, or the skin irritated with the most violent faradic current, without producing the slightest sensation or discomfort. Over the fore-arms and hands, by repeatedly roughly pressing the muscles against the bone, or by roughly stroking the skin, the patient says that she feels "something," but cannot describe what it is. Striking a bony prominence is perceived somewhat more quickly, though the blow requires to be sharp. With the ordinary test of the anæsthesiometer, tactile sensation seems to be quite abolished everywhere in the hands; yet the patient is able, though with difficulty, to find a pledget of wool placed on a cotton cloth before her, or to pick up a glass and place it on her head, or to touch the tip of the nose with the forefinger, or unfasten a button. None of these trials succeed readily, and only after a number of attempts does success come. Bandaging the eyes seems to make but little difference. Stopping the ears with cotton wool makes the ability to pick up small objects more uncertain; it then requires larger objects, and many more contacts before the object is perceived, and renders the act of touching the nose nearly impossible. When the eyes are bandaged and the ears closely stopped, the patient becomes quiet, the respiration perceptibly lengthens, but sleep does not follow, though the experiment be continued for a number of minutes.

Ordinarily the sense of hearing is used, and very accurately, in localising the position of objects, *e.g.*, a palm-leaf fan being placed before her, she will move the hands around until it is struck somewhat sharply and a sound produced, when it is immediately grasped. Objects that produce no noise on contact are not readily discovered. A pencil placed in her hand is recognised by pressing the sharp point against a bony prominence of the finger, but any round object is mistaken for the pencil. A hat placed in her hands was not recognised for some seconds, until the hand swept around the crown, when she mentioned the word "hat" with hesitation. When the first joint of my index finger is placed on the tip of her nose, and the patient told to touch it, it is impossible for her to accomplish the feat without first striking her own forehead sharply two or three times; by doing this she seems to derive a certain sense of locality, and is then able to touch my finger once, after which she fails until the forehead is again tapped several times, then it is possible to touch the finger again.

The æsthesiometer and light stroking of the skin having failed to establish if a degree of ordinary sensibility was present or not, and it being evident from the other tests that a portion of it is retained, the following method was devised by which both observer and patient could perceive the same impression at the same moment, and the errors of the patient could be corrected to a certain degree by the observer.

The slow vibrator of a faradic battery is made to beat a minimum number of times per minute. A large electrode is taken in the left hand of the operator, who thoroughly moistens the tip of the index finger of the same hand, and applies it to the volar surface of the tip of one of the patient's fingers, where there is no muscular tissue. A small well moistened electrode is then applied to the other volar surface of the finger; then patient and observer receive co-equally the sensation of the electric discharge.

Using this arrangement, Mrs. R. says she feels a "beating something" in the tips of all the fingers of both hands at the moment of the discharge; whereas, when the

electrodes are applied directly to the fingers the sensation produced cannot be described, nor can it be felt by the operator. The sensation described as a "beating something" does not appear to be a retarded one, as it is mentioned directly after the fall of the hammer.

Therefore, according to this test there remains a certain small amount of ordinary sensibility in the fingers, sufficient to enable her to pick up and hold objects, though not sufficient to accomplish many of the finer movements.

No difference is felt between ice applied to the skin anywhere (except the soles of the feet), and a temperature of 100°F. Faradisation of the skin is equally without result. The muscular sense, when the patient is reposing, is moderately well preserved. The position of the arm, when placed over the head, is most often recognised, some failures with a good many successes. The position of the feet is not so accurately known. The bed clothes are not felt, and generally when recumbent the patient appears to have an indefinite idea of her general position. When made to stand with the feet close together, she almost immediately falls backward and to the left. If supported, she sways violently, and becomes considerably agitated. The sitting position is quite comfortable.

Pressure with weights upon the forearm, the arm being on a firm surface (half to one-and-a-half kilogrammes or more) is not perceived; squeezing the muscles sharply against the bones is again described as a "something."

With weights suspended by a thread around the middle of the forearm, a difference between 80 and 112 grammes,—about one quarter—is recognised. Over the bony prominences the difference is greater, one-third not being recognised.

On the trunk, thighs, and legs, all sensations are the same as on the upper extremities. On the dorsum, sides of the foot, and all over the upper surfaces of the toes, tests are also negative. On the soles of both feet, almost symmetrically situated with each, commencing at a point about three centimetres in front of the heel and extending over the plantar surfaces of the soles and toes, sensations

are almost perfect; slight touches with a needle produce a quick withdrawal; a touch upon the plantar aspect of the toes is instantly recognised and accurately located. The points of the calipers are distinguished at normal distances; heat and cold are accurately distinguished. The sensitive line passes just a little over the edges of the outer and inner metatarsal bones, where it is suddenly lost.

Locomotion is of a blind person. There is nothing approaching an ataxic gait; the woman shuffles along, seeking aid and direction from the furniture, slowly and uncertainly finding her way about. The sensibility of the soles is unconsciously used, much more than any sense of touch in the fingers.

Mrs. R. has at times a sensation of burning between the scapulæ, a girdle feeling around the abdomen, and occasionally tinglings in the calves of the legs, but there have never been any lancinating pains. There are also occasional cramps in the gastrocnemii.

Both nerves and muscles respond energetically and promptly to the faradic and galvanic currents, nor is there anything noticeable about the quality or time of the reaction. The uvula and lingual muscles respond to both currents; the uvula hangs directly in the median line. All the voluntary muscles respond to the will. When the faradic stream is passed directly through a muscle, the sensation is described as a "darting something."

The cutaneous reflexes are abolished, with the exception of the plantar, which is present and lively. The knee-jerk is present and normal, the biceps-jerk can be elicited with some little trouble. The abdominal is lost. There is one beat of the ankle joint.

The ires contract feebly with reflected light. An ophthalmoscopic examination gave the following find:—Right eye: lens very milky, so much so as to obscure the retina entirely. There is absolutely no perception of light in this eye. In the left eye the lens is somewhat milky, the fundus very slightly pink, optic nerves atrophied, vessels very few and small. The difference between light and darkness is recognised, but there is not sufficient vision to count fingers, or perceive the hand when closely approached to the face.

The patient was placed on the iodide of potassium, gradually increased to 120 grs. per diem, with but little effect, except to increase the salivary secretion, which relieved the dryness of the mouth. Mercury was also tried without result. Specific treatment after a trial of three months was abandoned, and the patient placed on bark and tonics.

During the month of September, a fibrillary clonic spasm of the facial and arm muscles began, especially marked in the adductor muscles of the thumbs; which was succeeded toward the end of the month by pronounced cramps in the flexor muscles of the arms and legs, accompanied by a considerable degree of muscular pain. There is now a good deal of sensitiveness when the muscles are pressed against the bone, which has not been noticed previously. Morphia and quinia relieve the cramps and twitchings.

The sole of the right foot has become entirely anæsthetic, the left has still a small area at the base of the great toe, where tactile and pain sensations are still perceived. This anæsthesia of the soles varies slightly from day to day, sometimes a little greater, sometimes a little less. The knee-jerk is still present.

The secretions of the buccal cavity have considerably increased in the past few weeks, and the tongue has become cleaner and less cracked.

October 18th.—The patient's general health has altered perceptibly for the worse; there is now continued diarrhœa, which does not yield to treatment. Intense abdominal and leg cramps are constantly complained of. The spreading of the anæsthesia over the soles of the feet has had the effect of confining the patient almost entirely to bed, as she is no longer able to move about without constant danger of falling.

December 9th.—Sensation has returned to the soles of the feet after having been totally absent for a number of weeks. Thermic, pain, and tactile sensibility, is now quite as acute as in July. Patient is, however, confined to the bed by the diarrhœa, which can only be relieved by a continued milk diet.

Renewed trials of the sensibility of the buccal mucous

membrane shows a persistent absence of the tactile and thermic sensibility, as well as total analgesia. During the past few days transient attacks of dyspnœa, with palpitation of the heart, have occurred, especially at night. The pulse is now, during sleep, 112 per minute, regular, but rises on slight excitement to 140 beats.

July 16th, 1891.—Since the last note was taken there have been but slight changes in Mrs. R.'s condition; eyesight, smell and taste remain in exactly the same state. Hearing has altered perceptibly, high pitched notes are either not heard at all, or only imperfectly. The same watch that a year ago was distinctly heard at the distance of 36 cm. is now sometimes not perceived by either ear, even through the medium of the cranial bones; at others it is heard indistinctly a centimetre from the auditory orifices, at others only on contact. The variation is from day to day, like the anæsthesia of the soles was at first. The voice is still heard distinctly, though apparently the attention has to be constantly on the strain.

The different cutaneous and muscular sensations have remained about stationary. Tactile sensations are perhaps a trifle greater. Over the entire body, including the soles of the feet, thermic sensibility is totally absent. Analgesia to pin pricks, to the faradic current, is present everywhere, except in limited areas on the anterior portion of the soles of the feet. Tactile impressions of the rougher kinds are present in limited degree, but are evidently from the slow and uncertain movements, and the almost impossibility to touch the tip of the nose, the difficulty experienced in fastening a button, or in the more complex movements, very greatly dulled. The knowledge of the position of the limbs is even less positive than on the last examination. Differences between weights are no longer distinguished even between 60 grammes and more than half a kilo. It is no longer possible, for the patient to stand upright, nor has it been for several months.

The Strümpell experiment is still unsuccessful; with the eyes and ears closed, the woman simply becomes very quiet, the respiration deepens, but sleep does not follow.

Coarse muscular power is almost completely lost; the indicator of the dynamometer is not even moved on the scale. The response of the muscles to faradism and galvanism is prompt, and does not show any qualitative changes. Irregular muscular contractions have become a prominent symptom at times. Rapid jerkings of the head to one side or the other, or flexion of the forearm on the arm, or the leg on the thigh, occurs a few times daily.

The cutaneous reflexes are almost universally lost. The right knee reflex is uniformly not present, the left is very weak and only to be elicited with difficulty. The biceps and abdominal reflexes are absent. The right plantar reflex is also absent; the left is sometimes absent, sometimes present.

Numerous "miseries" are complained of in the limbs, though the principal pain symptom is a severe deep-seated occipital headache of a neuralgic character. Some shooting pains in the lower limbs are occasionally mentioned, but do not seem to be at all severe. The muscular spasms and pains are more intense during the night than in the daytime.

A few painless gastric crises have occurred during the winter and spring, the last being in the latter part of June; none have been severe or long continued.

The general health of the patient is not quite so good as it was a year ago. The appetite and all desire for food is entirely lost; milk is the only food that she can be induced to take constantly.

The psychical condition has undergone but slight change, she is possibly a little apathetic, with some slight tendency towards a melancholic tone, but when aroused and induced to converse for some time, this in great measure passes away. The memory is quite good.

August 15th.—A purpura simplex, in the form of bright red triangular points, has appeared over the left side of the thorax, from the fifth to the tenth rib, without apparent cause, and unaccompanied by any constitutional disturbance.

The vegetative functions, so long as the milk diet is continued, are natural. When questioned how she knows when to urinate, she replies, "I feel a pricking pain in the lower

part of the abdomen." The identical pain occurs before defæcation. The urine still contains no unusual constituents; the quantity is moderate, specific gravity 1018.

The muscular sense is preserved in about the same degree as in the previous year; the position of the upper limbs is recognised, but not always accurately. Forced positions of the lower limbs are unrecognised, nor can she tell the distance the feet are from the floor when they are raised. Standing alone is quite impossible. Occasionally she will fall out of bed when attempting to move about. When supported between two persons, and told to walk, the attempt is unsuccessful, from an apparent want of knowledge of the position of the feet; they only turn and twist under her. There is sometimes vertigo, and a sensation of turning around when recumbent, nearly always in the sitting position.

A bulbous appearance is now apparent to the tips of all the fingers, but especially in the tips of the ring fingers, which has developed during the past six months. The nails are ridged longitudinally.

The heart's action is feeble; no pronounced murmur. Pulse 96; tension slight; respiration 20.

August 25th.—The purpura has entirely disappeared. Considerable deep seated pain is complained of in the mastoid processes, and post-nasal region. Pharynx very slightly congested. A sound may be carried over the epiglottis into the larynx, down the œsophagus, or upward into the posterior nares without inducing cough, discomfort, or reflex action, and without any knowledge on the part of the woman that anything is being done, other than her throat looked into.

Natural sleep is obtained in moderate amount from three to four hours during the night, seldom in the daytime.

September 16th.—The condition is unchanged since the last note was taken.

CASE II.—Mary Z., æt. thirty-five, a Russian peasant by birth, was admitted to the surgical ward of the hospital, August 2nd, 1890, for syphilis.

The patient has been in this country only about a year, and speaks very little English, making the medium of an

interpreter necessary, and rendering an accurate examination in certain respects difficult. The family history, so far as can be learnt, is entirely negative. The father and mother were living when she left Russia. Patient has had good health until she contracted syphilis some thirteen or fourteen months ago. After being in the surgical ward about two weeks she became unable to walk, and my attention was directed to her by the resident physician, Dr. Hains.

Present state: August 20th.—The patient is a short, muscular, well-developed woman. The cranium is small, brachycephalic, symmetrical in contour, though the arch is a little low. The forehead is covered with a scaly purple, late secondary eruption, with some tendency to ulcerate, and much bronzing of the skin where the eruption is fading. There are characteristic specific ulcers on both tibia, also with much pigmentation. The skin from the scalp to the soles of the feet is covered with a profuse, oily, inodorous sweat, intensely disagreeable to the hand.

The abdomen shows the marks of a pregnancy. The fauces are slightly reddened, but not ulcerated. There is complaint of deep-seated pain in the thorax and abdomen. The heart sounds are normal; there are no râles or dulness on percussion. Pulse 88; temperature 99-100°F. On palpation extreme abdominal tenderness, especially localised about the pyloric end of the stomach and margin of the liver; there is also slight occipital headache. The expression is slightly apathetic when in repose; when aroused this quickly vanishes (for a few days after her confinement to the bed, patient was slightly irritable, a condition that soon passed into the usual state of cheerfulness).

The tongue is protruded straight, the facial muscles re-act normally to the will; the lips are naturally pursed in the act of whistling.

Hearing for both high and low pitched tones is normally acute. The pupils re-act naturally to light and accommodation. Vision is fair for near objects, for distant ones not so good. The fundus is apparently healthy. Colours are recognised so far as the woman is able to name them in English.

Odorous substances—ammonia, &c.—are recognised, but with extreme slowness. The mucous membrane of the nares is dry and congested. The nares may be irritated with a feather, without producing the slightest reflex movement. Gustatory sensations are absent from the anterior two-thirds of the tongue; over the posterior portion and arches present.

The grasp of the left hand is considerably stronger than the right. (The left is now always used in feeding herself, the reverse of the action when she was admitted to the ward.) The muscular tone is considerably diminished in the inferior half of the body; movements of the feet are feeble and uncertain.

The skin reflexes are either inhibited or very feeble. The plantar is absent on both sides. On the left side the knee-jerk is extremely weak, hardly to be elicited; on the right it is a little below normal. The abdominal is extinguished.

It is impossible for the patient to stand upright with the eyes unbandaged; the muscular strength is quite sufficient for her to rise to her feet, but the loss of equilibrium is immediate, and she falls backwards and to the left. Even a sitting position is to be maintained only for a few minutes; then with the arms outstretched, supporting her as props. Even then she sways violently from side to side and backwards; the face assumes an anxious expression, and if the upright position is persisted in for a few minutes longer she becomes very uncomfortable. When asked what ails her, she answers that her "head turns round."

Cutaneous sensibility, thermic, pressure, pain, tactile, is absolutely wanting with the usual tests over the whole body, except in a limited area, symmetrical on the anterior aspects of both thighs, beginning some four centimetres back from the patella, and extending over an area six centimetres broad by eight centimetres long. Within this space tactile impressions are perceived and localised, heat, cold, and pain distinguished. On every other portion of the cutaneous surface, the most intense faradic current, heat, or ice, produce no withdrawal of the extremity. Pressure on the ulnar nerves elicit none of the usual sensations of tingling in the fingers.

When the eyes are bandaged, it is impossible for the patient to discover a small object, as a coin, placed on a cloth before her; with a larger one, a water glass or india-rubber ball for example, it requires repeated sharp contacts before it is perceived, and then it is quite as difficult for her to grasp it, as it is lost as soon as found. When directed to pick up a light cotton ball, her hand having been placed on it, and put it on the top of her head, success is finally accomplished after a large number of failures. It is all but impossible for her to touch the tip of the nose with the forefinger. The attempt gives rise to a series of jerky, irregular, incoordinate movements, during which the finger may wander all over the shoulder and neck, rather than the face. Touching the tip of my forefinger placed on her nose is without success; fastening a button is impossible. So far as may be determined, the position of the limbs is totally unknown to her, and her sensation is one of floating in the air when recumbent.

The finger may be passed all over the eyeballs and corneæ without producing any reflex movements or withdrawal.

The lachrymal secretion, while scanty, is sufficient to keep the conjunctivæ in a natural condition. The oral secretion likewise is not abundant, though enough to keep the buccal cavity moist.

The facial and eye muscles respond energetically to natural and artificial stimuli. The tongue is protruded straight, without fibrillary tremor. The neck muscles respond normally to faradism and galvanism. The muscles of the left arm respond energetically to the faradic current; the muscles of the right arm very feebly. There is no difference in the reaction, or time of contraction in the flexors or extensors. With the constant stream, the left arm muscles respond naturally. The right arm muscles require a larger number of cells (three to five, Barrett) to produce a rather slow contraction, AnClC, in all the muscles. Both inferior extremities respond slowly and feebly. The muscles of the legs require forty-two cells of the same battery to produce any contraction, which is then

very feeble and quite slow; AnClC in both. Fibrillary twitchings were noticed for the first time on August 31st in the inferior extremities, but only lasted a few days. The muscles of the extremities are flabby, but not atrophied.

A more thorough examination of the gustatory perceptions gives complete gustatory anæsthesia over the anterior two-thirds of the tongue. Salt is nowhere perceived when the tongue is coated with it, or when the organ is rolled around the mouth. Quinine is not perceived over the anterior two-thirds, but distinctly on the posterior third, roof of the mouth, and palatine arches. There is a slight faucial reflex and nausea when the brush is passed down upon the epiglottis. With the constant current, using two to three cells of the Barrett battery, over the anterior two-thirds there is absolutely no perception anywhere, but as soon as the region of the circumvallate papillæ is reached the patient signs that she perceives something, and when asked to tell what it is, the interpreter translates "brassy." The line between the part where sensation is present or absent, is very sharply defined; moving the double electrode a millimetre either way instantly causes a change in the facial expression, and rise of the finger. Over the roof of the mouth, palatine arches, and velum, the electric current shows that sensation is present. On the posterior wall of the pharynx there is some doubt, the patient resisting the examination. Loss of tactile sensation is apparent over the greater portion of the buccal mucous membrane and fore part of the tongue. In the posterior portions, ordinary sensibility, heat and pain sensations are present, though not very acute, though the insertion of a needle in the posterior portion of the tongue, arches, &c., produces withdrawal.

September 2nd.—The facial expression is brighter, the sensorium clearer, the eyesight evidently improved. The cutaneous anæsthesia is unchanged in general, though there is some return of sensation in the first branch of the right trigeminus. Tactile and pain sensation are perceived on the right side of the forehead and scalp, but sensation is lost exactly at the middle line.

September 9th.—Anæsthesia of all kinds is to-day complete, from the crown of the head to the soles of the feet; the sensitive areas on the thighs, and in the department of the first branch of the trigeminus, having vanished completely. The abdominal pains have to a large extent disappeared, and there seems to be no visceral complication whatever.

September 13th.—The patient occasionally sits upright by the bedside, with arms widely extended for support, but it is impossible for her to maintain the position long, the intense vertigo still continuing. The deep reflexes have altered considerably; the right knee-jerk is now a little exalted, while the left is about normal. The superficial ones cannot be elicited. The sweat secretion has lessened greatly. Smell, taste and hearing, remain as they were in August.

September 24th.—Sensory paralysis of all kinds remains the same. The intense sweating has reappeared, and become malodorous, though the external temperature is not high (68° F.). The specific eruptions and ulcers are healing rapidly under the influence of mercury biniodide and inunctions.

The reaction with the constant current is now for both arms AnClC; KClC, very weak and quite slow. Well marked AnClC and AnOC in the forearms, with slow wave reaction. In the legs AnClC, KClC, very slow and feeble. Reaction from both nerves and muscles are the same. With the faradic current there is scarcely any reply. The extremities have now decidedly less muscular force than a month before. Fewer cells are required to produce a contraction than at that time. The equilibrium is still lost when sitting upright. The knee reflex remains in the same state; there is no plantar reflex or ankle beat on either side.

Z. has had several well-marked chills, malarial in nature, on alternating days; after each the temperature would run up to 105°, and subside next morning to 101°. Administration of quinine was followed by immediate benefit.

September 30th.—The patient has improved in every way during the past three or four days. This began immedi-

ately on the subsidence of the malarial attack. She is now able to go to stool, &c., with the support of another person. The muscular tone of the legs and arms is improving. The anæsthesia remains stationary. At this date my service in the hospital ended, and I afterwards saw the case only at irregular intervals.

October 18th.—The improvement in the general health continues slowly and equally. Z. is now able to move about the room without aid, and with comparative comfort, though sudden jerks and halts to preserve the equilibrium interrupt her progress. She is yet unable to stand still without swaying violently. Tactile and pain sensations have returned in the tips of the little, index, and middle fingers of the left hand, elsewhere sensibility is unaltered. The hand grip is somewhat stronger. Both knee jerks are now present, but weak; the plantar and abdominal reflexes are absent.

During the months of November and December the return to the normal state continued gradually and progressively. Just before the return of sensation in the fingers there was the appearance of exceedingly slight thinning of the skin of the finger tips, and a transparency of the nails, but no pronounced trophic lesions. Gradually, and a little irregularly, sensation extended over the hands and feet, the muscular strength returning with it; the difficulty in preserving the equilibrium became less and less marked, and the patient was assigned some duties in the ward which she performed with diligence. Progress to health was once interrupted by a renewal of the malarial attack from which recovery was rapid, and in March, 1891, at her own request she was discharged, though there was still a considerable degree of anæsthesia over the superior portions of the limbs and trunk. Since this date the case has been lost sight of. Both knee jerks were present and normal when she was discharged. No electrical examinations were made after September. The urine always remained free from albumen and sugar. I was never able to obtain from her a correct idea of the sensations that produced the desire to urinate and defecate, the only noticeable feature about

these actions being the extreme regularity at stated times in going to the commode.

The array of sensory symptoms in both cases are strikingly similar; in the first, total loss of thermic, analgesic, olfactory, gustatory, equilibrium, pressure, and weight; partial of tactile, muscular impressions, muscular sense, and auditory perceptions; uninvolved were none of the special or cutaneous sensations. Coupled with these were certain pains, mostly of a neuralgic type, located mainly in the extremities. Of motor pareses there were none.

In the second case, there was also complete thermic, pressure, equilibrium, gustatory in the anterior two-thirds of the tongue, weight, ordinary tactile and muscular feeling, almost total of the muscular sense, olfactory perceptions probably only involved through the implication of the trigeminus. Uninvolved, ocular and auditory impressions, the former perhaps a little dulled for the first few days after the beginning of the illness. Pain was also present at first, but passed away completely in a few weeks, taking rather the form of a prolonged *douleur* than a true neuralgic type. Motor pareses of the four extremities with qualitative alterations to the electric currents.

Beyond the likeness in the sensory symptoms of the two cases, there is little else in common between them.

In the first, there is a profound history of family insanity, which would suggest an instability of the nervous system of the patient. A certain amount of doubt must also be entertained of a self-given history in respect to sensory disturbances, as it is obvious that a patient is not a competent judge of many sensations. The very gradual progress of the affection during the past year, the very great masking of the sensory troubles from the woman by the eye affliction, and consequent inability to perform active movements, or attend to daily work, renders it rather a matter of suspicion whether the sensory disorders, especially those implicating the thermic and pain departments, were noticed until what I have termed gastric crises arose, which, together with the extreme dryness of the buccal cavity, caused an application

to a physician for relief, and that the trouble has been one of slow and gradual progress for many months before the continued vomiting spell toward the end of 1889, possibly beginning shortly after the attack of rheumatic fever. When I first saw her in July, 1890, except for these two causes of distress, the patient was in large part ignorant of her anæsthetic condition, her only cause of complaint on that score being that she could not feel or find things so well as formerly. Partial recurrences of the paræsthesias of December, 1889, have recurred with too great frequency to allow of any weight to be thrown on that time as the beginning of the affection.

Etiologically between the first and second cases there is only one common ground of nerve disease, and that is syphilis, but with good reason for the belief it may be held that that agent had nothing to do with the causation of the anæsthesia in either observation.

In the first case, besides the direct induction of a diffuse degeneration through the agency of the syphilitic virus, we have to consider (1st) syringomyelia, which in view of the Spaeth-Shüppel observation cannot be absolutely excluded, yet the absence of muscular atrophies, and the great loss of the tactile sensibility, as well as the absence of spinal curvature, is against the theory. True, there has been some bulbous appearance lately in the tip of the finger tips, with longitudinal ridging of the nails, but these occur in other nervous affections, and in this particular instance may be referred equally well to the slight want of tone in the heart's action, with consequent defects in the circulation.

Secondly, hysteria may with certainty be excluded; the age of the patient, the equal temperament, never excited, hardly depressed; taking interest so far as her limited powers permit in whatever is going on around her, never objecting to the oft-repeated examinations, sometimes trying and exhausting to a person with so little muscular strength, does not portray a common case of the disease.

I have mentioned in the history an apathy that has been manifest in the last few months. This is only partial, and is undoubtedly connected with the diminution of the

power of hearing. From it she can be easily aroused, and though her conversation is mainly about herself, she is rather contented and resigned to her fate than otherwise. What can one expect other than an apathetic condition in a person confined strictly to the bed, sans eyes, sans nose, mouth, or feeling, to carry impressions from the outer world, reduced to the sole imperfect sense of hearing? I doubt not that anyone living, no matter how naturally cheerful they may be, when placed in the same circumstances, would become more or less apathetic. Of true melancholia there certainly is none; the woman expressed her condition better than many words can tell when she once told me, "I have become a perfect dummy."

I am therefore inclined to refer the sensory state to a condition of the cerebrum approaching a psychosis—not one, so to speak, of the intellect, but an analogous condition of the sensory sphere, occurring in an hereditary *déséquilebre*, with an anatomical ground in the sensory (sensitive) cells of the cortex, fine perhaps as in the true psychoses, and as unattainable by the microscope as they are to-day, but nevertheless there, perhaps to be ascertained in future years by finer processes of hardening and staining yet unknown. In regarding the sensory disturbance as functional, I am in accord with Strumpell, Eisenlohr, Heyne, Krukenburg, and von Ziemssen.

With reference to this particular case, the least clear point in the theory is the extinction of the spinal reflexes; in Krukenburg's and von Ziemssen's cases they were either normal or increased in activity, and in Strumpell's some increased, some lost; in the present one they were all lost or greatly diminished, with the exception of some involuntary ones. With the skin reflexes this objection might be overcome, as many lesions of the cerebrum that cause hemiplegia also cause a diminution of the cutaneous reflex action on the paralysed side, but such is not the case with the muscle reflexes, and any inhibition of the cortical centres would produce overaction, not inhibition. We must therefore conjoin with the functional disturbance of the hemispheres a like disturbance of the cerebellum, which will also

account, in some measure, for many other symptoms; the most prominent being the inco-ordination, muscular sense, turning sensations and vertigo.

To the present date but three autopsies have been obtained on cases of cutaneous and sensory anæsthesia—von Ziemssen's and Krukenburg's, with no pathological change in either the peripheral or central nervous system, and Shüppel's, which, as elsewhere mentioned, turned out to be a case of syringomyelia.

A coarse bilateral lesion affecting the sensory fibres, where they run closely together in the pons, peduncles, or posterior part of the internal capsules (even supposing for the moment that the paths of the olfactory, gustatory, and auditory sensations, as well as the cutaneous and muscular sensibility, run all together in this region of the brain), so limited on both sides as not to involve anything else than sensory fibres, is to my mind an impossibility, and we are obliged to turn to a functional disturbance of the cortex of the hemispheres and cerebellum, or preferably to an organic lesion of the cerebrum, to the other extremity of the nerve tracts, the terminal end apparatus.

In our second case, I think hysteria may also without doubt be excluded by the equal and cheerful disposition of the woman, as well as by the general course of the disease; rising to a certain point of intensity, stationary for a time, followed by a decadence of the acuter symptoms and a gradual recovery; but above all, by the qualitative electro-muscular changes.

An epitome of the observation gives the following: a woman in the late stages of secondary syphilis has suddenly an inability to walk from severe vertigo; there is at the same time slight fever, accompanied by headache and bodily pains of some continuance, succeeded in a few days by a notable paralytic weakening of the inferior extremities and of the right forearm, followed later by a milder implication of the left, with changes in the skin and muscle reflexes of an inhibitory character. The muscular pareses increase with the deepening of the anæsthesias, until certain qualitative changes are produced on the application of the

electric currents, approximating a partial reaction of degeneration in the fifth and sixth weeks of the course of the disease; then follows an intercurrent malarial attack, after which recovery was very gradual and progressive, sufficient to enable her to leave the hospital towards the end of the seventh month.

The main point to determine in the history is whether the muscular pareses were apart and separate from the anæsthetic affection—a motor neuritis of a mild type concomitant with another affection, or are they only separate divisions of the same disease. From their beginning together, progressing together, and diminishing together, it can hardly be considered doubtful that they were common symptoms of a single trouble, a polyneuritis of a toxic nature, occurring in the course of a syphilitic affection; but whether caused by the specific virus of that affection, or by some other toxic material acting on an already depressed nervous system, must remain only a subject of conjecture. I cannot but consider the malarial attacks that twice interrupted the progress of the malady as anything more than a mere accidental disturbance, which seemed to have a rather beneficial influence than otherwise.

Diagnostically, but three other affections are to be thought of besides hysteria in considering the case. First, a central affection of the gray matter of the medulla and spinal cord, combined with a neuritis of the peripheral nerves; secondly, a syphilitic exudation of a hæmorrhagic-gummatous nature, involving the spinal nerve roots from the lumbar region to the pons, and of a more intense character in the spinal than in the pontic regions; or lastly, a simple toxic neuritis having a special affinity for the sensitive fibres.

To the first hypothesis I am strongly inclined in view of the recent numerous cases of polyneuritis that have shewn, besides the peripheral lesion, an implication of the central nervous system, and especially of the posterior region of the cord.

Of mental alterations in this case there were absolutely none after the first few days of fever. The slight mental apathy and dimming of vision, followed by a slight degree

of irritability, are perfectly in accord with the febrile movement; perhaps had the toxic influence been more severe, there would have occurred symptoms analogous to Korsakow's polyneuritic psychosis, and made more pregnant its relation to the psyche.

That Strümpell's sleep-inducing experiment should have been unsuccessful with R. cannot be a source of surprise. The woman had received in her youth a moderately good education in a private school in Islington, London; she is intelligent, the memory is fairly good; ordinary sensibility is to a small degree preserved; altogether the conditions differ widely from Strümpell's in a boy of fifteen years, and Krukenburg's of a very pronounced melancholic temperament, as well as from Von Ziemssen's with rapid dementia. Our patient had the memories of the past to fall back upon; the loss of eyesight in the recent years would induce her to be more reflective; besides, its constant disuse may also come in as a not unimportant factor. On one occasion I bandaged the eyes and packed the ears with cotton; the respiration deepened slightly; then I left her for ten minutes. She lay perfectly quiet, but on removing the bandages it was seen that she was not sleeping. In the second case through some lapsus the experiment was not tried.

Inco-ordination in both cases was mainly of a cerebellar type; a reeling gait, a tendency to a zig-zag direction, and oscillations in the walk, an inclination to sway violently from side to side and vertigo, were the principal features, better marked, however, with Z. than with R. Even to the latest date of the history, implication of the arms is to a large extent absent with the latter, but it was much more prominent with the other woman. In neither case was there the extreme irregularity of the movements of the legs that characterise an ordinary case of locomotor ataxy, nor the involuntary contraction and relaxation of the muscles of the hands and feet.

The preservation of the muscular sense in some part in the first case, as well as its not total abolishment in the second, is an interesting feature. With R. a well marked

loss in the legs was first apparent after the commencement of the inhibition of the knee reflex, accompanied at the same time by an increase in the anæsthesia of the soles of the feet. Only at this period was the reeling gait very evident, to be succeeded before a great many weeks by a total inability to take a single step.

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ON THE LOCALISATION OF THE AUDITORY CENTRE.

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ALTHOUGH the localisation of the auditory centre or sphere in the first or in the two upper temporal convolutions is generally admitted, this view has not received universal acceptance; therefore, the great value of the history and autopsy here recorded will be acknowledged.

The recent views with reference to auditory localisation mostly agree in placing the auditory centre or centres in the temporal lobe, but differ as to their exact position in this lobe or as to the extent of cortex included in the auditory field. According to Munk, whose theories have been based chiefly on experiments performed on dogs, the auditory sphere is at a position corresponding in the monkey and the man to about the middle temporal gyre, considerably lower in the temporal lobe than Ferrier's localisation. In the upper or posterior portion of the superior temporal convolution, to which Ferrier gives the preference as the seat of the auditory centre, Munk localises the area for sensibility of the auricle. Luciani includes in the auditory sphere the parts which correspond to the upper temporal gyres, but, in addition, a large part of the cortex which is concerned with other functions. Schafer repeated Ferrier's experiments in a number of monkeys, obtaining some of the results of this investigator, but failing to get others. In conjunction with Dr. Sanger Brown, he, in six cases, more or less completely destroyed the superior temporal convolution on both sides,

and claims that in all, hearing was not only not abolished but was not perceptibly affected. In one of the six monkeys the whole temporal lobe of the one side was removed, and yet Schafer holds that the animal responded to all impressions of all the senses, but appeared to understand very imperfectly the meaning of such expressions. Sounds even slight in intensity were heard. He believes that this case militates strongly against the view that auditory perception is localised in the temporal lobes.

Ferrier has ably replied to the attacks of Schafer both in BRAIN, April, 1888, and in the Croonian lectures.[1] He also reaffirms the accuracy of his own experiments and the justice of his own conclusions. To clear this matter up, he reinvestigated the question. In one monkey in which he performed the operation of bilateral extirpation of the superior temporal gyre, with one month interval between the operations, the result was very striking. The following, in his own words, are the conclusions as to the condition of this animal after the second operation.

"At first it failed absolutely to respond to any of the tests which invariably attracted the attention of normal monkeys. To the last, with the single exception, perhaps, of the door of the laboratory from which it was always expecting something, it never realised the origin of sounds; it was altogether indifferent to sounds which formerly were full of significance to it, and all that could be said was that it was not, when otherwise occupied, insensible to sonorous vibrations. And it would have been difficult to make this out with any degree of certainty had it not been that the animal was one qualified to give oral testimony of the fact. Whether this form of auditory sensibility is to be attributed to portions of the cortical auditory centres undestroyed by the lesions described, or to the subcortical or mesencephalic centres, I am not yet in a position to decide."

He finds further confirmation of the localisation of the auditory centre in the superior temporal convolution in cases

[1] The Croonian lectures on Cerebral Localisation, delivered before the Royal College of Physicians, June, 1890. From these lectures the summary of the discussion of auditory localisation is chiefly taken.

of auditory discharges or subjective auditory sensations in connection with irritative lesions implicating this gyrus. "Gowers has reported two cases of this nature. In one a tumor, of which the oldest part was beneath the superior temporal convolution, caused convulsions commencing with an auditory aura referred to the opposite ear. In the other, a tumor affecting the superior temporal gyrus caused unilateral convulsions preceded by a loud noise as of machinery. And Hughes Bennett has reported several cases of auditory sensory discharges followed by a temporary loss of hearing in the opposite ear or in both. Thus, a woman, subject to epileptic attacks preceded by a loud noise like the ringing of a bell in the left ear, became temporarily deaf in each ear after each attack. Both ears were deficient in hearing, but the left undoubtedly more so."

The present case should be ranked as conclusive in the decision of the question of auditory localisation, the specimens showing an insolated lesion in the two upper temporal gyres of the left hemisphere, which caused word deafness, and also a later lesion of the two superior temporals of the other hemisphere with a history of almost total deafness.

Ferrier speaks of the extreme rarity of bilateral lesions of the superior temporal convolution, but gives two important cases in which these double lesions simultaneously or successively occurred. One case, first recorded by Shaw, is that of a woman who suddenly lost power in the right arm, with also loss of speech and word deafness. The loss of power passed away, but she became incoherent and subject to delusions, and on testing her she was found to be deaf and blind. The *post-mortem* showed atrophy of both the angular and the two superior convolutions of both hemispheres. The other was a case of Wernicke and Friedlander, a woman who, after apoplexy, had right hemiplegia, aphasia, paraphasia, and word-deafness. A few months later she had a second attack, causing paresis of the left arm, and she became absolutely deaf. Extensive lesions were found in the superior temporal convolutions of both hemispheres.

I have recorded the case of a man, deaf for thirty years, whose brain showed marked atrophy of both superior

temporal convolutions, particularly the left side.[1] Broadbent has recorded a similar case referred to by Ferrier.

Numerous cases of lesions of the superior temporal gyres of one side have been reported, and word deafness has most frequently been found an accompaniment of lesion of the left first temporal convolution. These facts are now well known, and have been put on record by various observers as Seppilli, Ferrier, Starr and others.

Word-deafness following an apopletic seizure—more complete deafness and partial left-sided paralysis following a second apoplexy—autopsy showing lesions of the first and second temporal convolutions of both hemispheres—a lesion of the first and second temporal convolutions of the left hemisphere, which probably accurately localises the centre for word-hearing.

The patient, a woman, aged 46 years, was admitted to the Philadelphia Hospital in August, 1891. She had a history of scarlet fever in childhood, of rheumatism many years ago, and also of old venereal disease. She had had five abortions or miscarriages, and had one living child, 23 years of age, who was deaf and weak-minded. For many years she had had valvular disease of the heart. She was right-handed. Some of the facts of her history were obtained from relatives who called to see her at the hospital, and others were procured after her death from a brother and sister-in-law, whom I sought out and carefully interviewed.

Fifteen years before her death she had an apoplectic attack which left her word-deaf but not paralysed. Prior to this first attack of apoplexy her hearing had been good, but after it she could not, by hearing, understand anything that was said to her. She could, however, hear music and sounds of various kinds ; for instance, when an organ or band had performed upon the street she at times had called attention to the fact; and she had also come down from the second or even the third story to open the front door in answer to a knock. She could hear such sounds as a bell ringing and a clock ticking. These facts were elicited from her relatives through various statements made by them, chiefly spontaneously.

When anyone wished to communicate with her it was done by means of writing or signs, as she had fully preserved her vision and was evidently not word-blind either for writing or printing.

[1] *University Medical Magazine*, November, 1889.

She often read the newspapers, and could do so with intelligence up to a few weeks before her death. Her sister-in-law said that several times she had heard her try to read the newspaper aloud, and in so doing she had seemed to understand fully what she read, "but made a tangle of her words." From the time of the first attack she had never been able to speak well, her words becoming "jumbled" or "tangled." From the description given of her manner of speech the defect was evidently a serious form of paraphasia and paralexia.

Her relatives spoke positively of her deafness as having been due to the "stroke;" but the apoplectic attack, although it had at once caused this word-deafness and paraphasia, had not in any way, as far as could be ascertained, affected either motion or sensation. She could write, but "sometimes mixed up her words in writing."

Nine years before her death she had another and more severe apoplexy, after which her deafness increased for sounds as well as words until it was almost total. This seizure left her also with partial left hemiplegia, chiefly affecting the arm, and in this extremity, from the description, the paralysis was more marked below the elbow. Upon examination after admission to the hospital, she was found to have some contracture at the metacarpophalangeal articulations.

Six weeks before her admission she began to have pain in the left side and abdomen, which gradually increased in severity. The day before her admission she had a chill and pain in the left shoulder and arm. For five weeks she had involuntary evacuations of urine, and for about two weeks she had been unable to retain her fæces. For these six weeks she had been much more helpless than previous to this time, often letting things drop from her hands. She seemed to suffer considerably from headache, and also slept badly.

She was first examined by me on August 24, 1891. Her condition then was one of almost complete helplessness. It was impossible to make her understand what was said to her, and so far as could be determined by repeated tests she was totally deaf; but notwithstanding her weakness, helplessness, and deafness, her face had a somewhat intelligent expression. She looked about her as if she knew what was going on. She was very emaciated; her heart's action was excited, and examination showed the presence of marked murmurs, both mitral and aortic. She became feebler day by day, and died August 28.

Autopsy.—No disease of the bone or of the dura mater was

found. Even before pia-arachnoid of the left hemisphere was removed, it was noticeable that the first temporal convolution was much smaller and thinner than usual, and that at the posterior extremity of it and of the second temporal, there was a depression covering a space about seven-eights of an inch in diameter.

The *left* first temporal convolution is remarkably small, narrow, and smooth, except at its anterior extremity. Its posterior two-thirds or three-fourths have shrunken to a thin strip. At a point about the middle of the gyre, the convolution has so disappeared as to leave only a notch and shred of tissue. Just anteriorly to this point a small annectant gyre runs to the second temporal. The attenuated appearance of this superior temporal convolution is such as to attract the attention of the most inexperienced observer of such appearances.

At a position corresponding to the posterior fourth of the second temporal convolution and the parallel fissure, the brain presented a marked depression or cavity, at the bottom of which, when the specimen was in the fresh state, was a small mass of yellow, shrivelled, puckered tissue. This was evidently the remains of an old embolic softening. The subarachnoid cavity, or cyst, which was present before the inner membranes were removed, was formed by this old necrosed area and the widened parallel fissure, this widening having chiefly resulted from the atrophy of the first temporal convolution.

In connection with the question of the part played by the second temporal convolution in cerebral audition, it is, of course, important to carefully describe the condition of this convolution. From the position of the annectant convolution, it was seen to be decidedly atrophied, and in its posterior fourth, or perhaps third, it has practically disappeared, and has been replaced by the cavity or cyst just described.

The third, fourth, and fifth temporal convolutions were undoubtedly not involved in either the softening or atrophy, as the brain was carefully studied by me in both directions, from the second temporal convolution to the hippocampal and the reverse.

Around the ascending branch of the Sylvian fissure and at the bases of the two central convolutions, much atrophy has evidently also taken place. This ascending branch of the Sylvian, instead of being a mere indentation or narrow fissure as is usually the case, is wide and gaping. The hinder portion of the third frontal, and particularly the strip of convolution between the ascending Sylvian and precentral fissure, is markedly wasted.

The retro-insular convolutions are two in number, and the

posterior of the two is very small. The anterior retro-insular presents the appearance of being a continuation of the anterior half of the first temporal, and the posterior retro-insular is continuous with the posterior much-shrunken half of the first temporal.

In the *right* hemisphere was an old and very extensive hæmorrhagic cyst which completely destroyed the first, and almost completely the second, temporal gyre, the island of Reil, retro-insular gyres, the lower extremities of the central gyres, and a large extent—but exactly how much could not be determined—of the ganglia and capsules. Examination from within showed that the caudate body and the thalamus had largely preserved their integrity, and the chief interior destruction was probably of the lenticular ganglion and the external capsule. In the posterior portion of the cystic area, some gyral substance is seen, but examination shows this to be the sunken in lower extremity of the inferior parietal convolution. As, on the other side, the supra-Sylvian bordering convolutions are much atrophied. The auditory nerves were atrophied. The acoustic striæ, usually so easily seen, and often so prominent, could not be made out with the naked eye.

Slight adhesions of the left pleura were present on both sides. The lungs were œdematous and exuded a turbulent fluid on pressure. The precardial sac contained an ounce and a half of fluid. The endocardium was thickened. The mitral valve was also much thickened, the orifice being so small that it would not admit the little finger. The aortic valves were in a similar but worse condition, and a clot was found in the left auricle resembling in appearance those seen in aneurisms. The spleen was small. The kidneys were small and presented on their surface large hæmorrhagic spots. On section the surface was found to be flabby, and the cortex and pyramids much distorted. The spots on the surface had irregular shapes, having the appearance of old and recent hæmorrhagic infarcts. The liver was small and moderately firm. The ovaries were dense and sclerotic.

A study of this case justifies the following conclusions:

(1) The centre for word hearing is situated in the hinder thirds of the first and second temporal convolutions; its exact position is in a line with, or just in front of, the posterior extremity of the horizontal branch of the fissure of Sylvius. Possibly it is restricted to the second temporal.

(2) The third, fourth, and fifth temporal convolutions take no part in cerebral audition.

(3) A lesion confined to the posterior thirds of the first and second temporal convolutions of the left hemisphere will produce complete, or almost complete, word deafness, the corresponding regions of the other hemisphere remaining intact.

(4) The field or sphere for all auditory memories covers a much larger cortical area than that for word-hearing, including at least the posterior two-thirds of the first and second temporal convolutions.

(5) The auditory field and special auditory centres have their highest development in the left hemisphere, but destruction of the auditory areas of the two upper temporal convolutions of both hemispheres is necessary to complete brain deafness.

(6) A lesion limited to the centre for word-hearing and causing word-deafness will cause also paraphasia in attempts at speaking, and paralexia in attempts at reading.

(7) An isolated lesion of the centre for word-hearing, producing absolute, or nearly absolute, word-deafness, does not necessarily cause inability to recall words by other means, as, for instance, through their visual signs; in such cases probably the meaning of the word is understood, although the name cannot be properly verified in consciousness.

(8) A cerebral lesion or lesions causing word-deafness will, in time, lead to secondary atrophy of the speech and oro-lingual centres on the motor or emissive side of the brain, and also to atrophy of the association tracts between the sensory and motor hearing-speech centres.

(9) The retro-insular convolutions are anatomically and functionally closely related with subdivisions of the first temporal convolution, the most posterior of these retro-insular convolutions being continuous with the posterior two-thirds of the first temporal convolution.

STUDY OF A CASE OF BULBAR PARALYSIS, WITH NOTES ON THE ORIGIN OF CERTAIN CRANIAL NERVES.

BY HOWARD H. TOOTH, M.D., F.R.C.P.

AND

WILLIAM ALDREN TURNER, M.B., M.R.C.P.

Bibliographical.—There is much literature on the anatomical facts of this disease, mainly from the pens of German and other Continental writers. Notwithstanding the large amount of attention which has been given to the subject, much ambiguity still exists regarding the exact anatomical lesions which occur. The intention of this short biographical account is to submit a statement of the facts observed by others, so that a comparison may be readily made between these and our own observations.

1. *Distribution of the disease in the white matter of the central nervous system.*—The various statements concerning the highest limit of the disease are of profound importance. Usually the sclerosis, which involves the pyramidal tracts alone, has not been found higher than the pons Varolii. But certain observers have described conditions which are believed to signify degenerative processes in the higher parts of the cerebrum. Kahler and Pick[1] traced the disease into the crura cerebri, and observed further, an atrophy of the cerebral convolutions of the Rolandic area. Kojewnikoff[2] noted that the sclerosis stopped at the level of the pons, but he was able to trace "granular bodies," which he had also found in the sclerosed area, through the middle third of the crura cerebri, the internal capsule and the coronal radiata. He also noted

[1] Kahler and Pick, *Prager Vierteljahrsschrift*, 1879.
[2] Kojewnikoff, *Arch. de Neurologie*, No. 18, 1883.

that the grey matter of the convolutions was of normal appearance. Charcot and Marie[1] showed, in addition to the "granular bodies," a disappearance of the pyramidal cells of the motor cortex. Lumbroso[2] saw these "granular bodies" in the internal capsule and in the cortical motor region.

In opposition to these observations, and of equal importance with them, are the negative results of competent observers, who have carefully looked for these cerebral changes and found them absent. Thus Debove and Gombault[3] searched in vain for the "granular bodies." Marie[4] failed to find any change higher than the pons Varolii. Rovigli and Melotti[5] noted the integrity of the cerebral peduncles and the internal capsule, and most recently Joffroy and Achard[6] confirm the intact condition of the pons and peduncles. In the spinal cord the sclerosis is limited to the tracts which are motor in function, chiefly the crossed pyramidal tracts, but also in some cases the direct. The degeneration is usually most pronounced in the cervical region, and there it has been found not to be sharply limited to the crossed pyramidal tract, but to extend some distance forwards into the antero-lateral area. Degeneration of the anterior ground bundle has been noted by many observers, *e.g.*, Moeli, Leyden, Flechzig, Charcot, and others.[7] Muratoff[8] found that in all cases where the anterior ground bundle was implicated the posterior longitudinal fasciculus was atrophied. This seems to favour Flechzig's view, that these two tracts are functionally analogous. Kronthal[9] noted slight degeneration of some of the fibres of the fillet, accompanied by some increase of the neuroglia. This also was observed by Muratoff.[10] A slight non-essential sclerosis of the posterior columns has been noted in some cases.[11]

[1] Charcot and Marie, *Arch. de Neurolgie*, 1885.
[2] Lumbroso, *Lo Sperimentale*, 1888.
[3] Debove and Gombault, *Arch. de Physiologie*, 1879.
[4] Marie, *Arch. de Neurolgie*, 1887.
[5] Rovigli and Melotti, *Riv. Sperimental*, 1888.
[6] Joffroy and Achard, *Arch. de Med. Experimental*, No. 3, 1890.
[7] Quoted by Muratoff, *Vide infra*.
[8] Muratoff, *Neurol. Centralblatt.*, 1891, p. 513.
[9] Kronthal, *Neurol. Centralblatt.*, 1891, p. 133.
[10] *Loc. supra cit.*
[11] Mentioned by Dr. Ormerod in a critical digest of Amyotrophic Lateral Sclerosis, BRAIN, vol. ix., p. 245, to which we are indebted for much valuable information.

2. *Distribution of the disease in the central grey matter.*—This consists of atrophy and disappearance of the multipolar nerve cells, which are included in Dr. Hughlings Jackson's "lowest level" (the bulbo-spinal centres), with the important exception that the oculo-motor nuclei are usually not degenerated. The greatest amount of atrophy is in the hypoglossal nucleus. The cells of the corpus dentatum of the inferior olive have been found affected by only one observer.[1] The nucleus ambiguus was found atrophied by Kronthal;[2] usually it is unaffected, as also is Clarke's column.

3. *Condition of the peripheral nervous system.*—Degenerative changes have been observed in the peripheral nerves in some cases. Joffroy and Achard[3] noted a parenchymatous degeneration of the nerves of the extremities in a case of this nature. Kronthal (*loc. cit.*) describes degeneration of several cranial nerves, while the peripheral spinal nerves were unaffected. Oppenheim,[4] in a case of chronic anterior poliomyelitis, found slight degenerative change in the mixed nerves, while the anterior roots were healthy. But it must be borne in mind that in many instances no change has been found in the peripheral nervous system.

4. *Nature of the change in the central nervous system.*—The sclerosis is in appearance similar to that of descending degeneration resulting from a cerebral lesion. That it is not due to a diffuse chronic myelitis is evidenced by the fact that the periphery of the cord, which is usually affected by the inflammatory condition, here completely escapes, and also the posterior columns. Whether the change be originally parenchymatous or interstitial is difficult to determine, as in the later stages the resulting sclerosis is the same; and early stages of this disease do not, as a rule, admit of pathological examination. Leyden observed that the axis cylinders were never hypertrophied, as occurs in disseminated sclerosis.

[1] Maier: *Virch. Archiv.*, vol. 61. (Quoted by Ormerod, *loc. cit.*)
[2] *Loc. supra cit.*
[3] *Loc. supra cit.*
[4] Oppenheim: *Arch. fur Psych.* Bd. xix.

Much uncertainty exists regarding the starting point of this disease. In "pseudo-bulbar paralysis" double lesions of a hæmorrhagic nature have been found implicating the pyramidal tracts above the pons, and giving rise to secondary degenerations on both sides. In the chronic progressive form under discussion, we have been unable to find any primary lesion recorded which would account for the more or less symmetrical nature of the sclerosis. Although some observers have noted changes of a degenerative nature in the large cells of the motor cortex, many cases have been recorded where no such alterations have been detected. The view that the disease is a primary affection of cells and fibres, motor in function, seems the only explanation which our present knowledge can justify.

We are indebted to Dr. Hughlings Jackson for permission to record the following case:—

CLINICAL SUMMARY.—*Onset with "loss of voice," shortly succeeded by hemiplegic weakness of right side and later on difficulty in swallowing. Admitted with paralysis of tongue, lips, palate, and vocal cords, weakness and atrophy of right arm and leg, and inability to articulate. Later on paralysis of right side and paresis of left, paralysis of the neck muscles and muscles of deglutition. Finally, paralysis of diaphragm. No affection of eye muscles and sphincters. Duration, about sixteen months.*

G. W. V—n, ætat. 43, was admitted into the National Hospital for the Paralysed and Epileptic, Queen Square, on October 8th, 1888, and owing to his inability to articulate, and difficulty in writing, a very brief history was obtained. In December, 1887, he began to "lose his voice," but shortly after this he noted a gradually increasing stiffness and weakness of the right arm and leg; he does not think that the left side of the body was affected at this time. Some five months later, in April, 1888, he complained of considerable difficulty in swallowing and inability to expectorate effectually. He has suffered no pain during his illness. He denies syphilis. He said he had rheumatic fever nine years ago.

Condition on admission.—The body is emaciated, the

expression is characteristic of the disease. This has been well described as "sad inanimate" while the temperament is buoyant and expectant. The movements of the face are weak on both sides, the orbicularis oris being especially affected, so that he is quite unable to whistle or put his mouth into the position for kissing. The upper facial group, frontalis, and corrugator supercilii is in a state of over-action, so that the forehead is crossed by deep wrinkles; the orbiculares palperbrarum act well and efficiently; the naso-labial fold is prominent on both sides. The lower facial group is weak; the lower lip hangs down and the mouth is slightly open. The tongue lies flaccid on the floor of the mouth and cannot be protruded beyond the dental arch: he is quite unable to articulate, an endeavour ends merely in the production of a noise. He understands everything that is said to him, he answers questions in writing, and he reads and appreciates the daily papers. Mentally he is facile, laughing and sobbing on slight provocation. The vision is good, the fundus of the eye is normal and there is no defect in the movements of the eyes. Hearing also is good. Dr. Semon examined the larynx and reported that there was bilateral and symmetrical paresis of the abductors; the glottis on inspiration did not open to more than three mm., on phonation there remained a small oblong gap between the cords (paresis of the internal tensors). There is paresis of the soft palate. He swallows pulps more readily than fluids or solids, but the taking of food usually starts a troublesome cough: this difficulty in swallowing appears to be due to an inability to get food into the lower pharynx. The vomiting and swallowing reflexes are not obtained on tickling the back of the tongue. The cardiac and respiratory functions are normal.

He walks with a feeble, hemiplegic gait. There is considerable wasting of the muscles of the right arm and hand, especially of the interossei and thenar groups. All movements are effected but feebly, except that he is unable to dorsiflex the right foot. In the right leg there is no marked wasting. The tendo Achillis is rigid. Both knee jerks are exaggerated, the right being more marked than the left.

An ankle clonus is not obtained: the plantar reflexes are active, the left more than the right. Defæcation and micturition are normal. The urine contains neither albumen nor sugar. The arteries are not atheromatous. *Electrical reactions.*—All the muscles react to the faradic current; but there is a quantitatively diminished reaction of the muscles of the right side in comparison with those of the left.

Progress.—Only a summary of the notes taken during the remainder of the patient's life is given here. By December the atrophy and paralysis had considerably advanced, the small muscles of the left hand being more atrophied than on admission. The faradic excitability of the right hand muscles had also correspondingly diminished; he could barely hold a pen in his right hand. In January, 1889, it was noted that the whole of the left side was becoming weaker and that he had great difficulty in chewing owing to paresis of the jaw muscles. At the same time a slight ankle clonus was observed on the left side, there was none as yet on the right. The condition of the hands was as follows:—Atrophy of the dorsal interossei and abductor indicis as well as of the thenar and hypothenar muscles, the position of the fingers is that seen in ulnar paralysis: the muscles all presented increased mechanical irritability. No fibrillary tremors were observed. At Dr. Jackson's suggestion the urine was repeatedly tested for the presence of sugar, but at no time, not even to within a few days of death was any observed. At no time during the course of the disease did the saliva trickle from the angles of the mouth.

In February the movements of the neck muscles were found to be feeble, flexion of the head backwards and forwards was effected for a short distance by muscular action, beyond this the head fell backwards or forwards by its own weight; rotation was, however, well carried out. Movement of the head occasioned considerable pain over the position of the Atlas. During the remainder of this month and the following the patient was unable to move in bed without assistance. Towards the end of March, the following condition was noted:—

Olfactory Nerve.—Sense of smell perfectly normal.

Optic Nerve.—Sight unimpaired; discs normal.

Oculo-Motor Nerves.—All ocular movements well carried out, but some coarse nystagmoid jerkings were occasionally observed on extreme lateral deviation; pupils medium and equal, react to light and accommodation; no ptosis.

Trigeminus (Motor branch).—Paresis, almost amounting to paralysis of masticatory muscles.

(Sensory branch.)—No impairment of sensation. Taste normal.

Portio dura.—Lower facial muscles completely paralysed, the upper group is in a tonic state of overaction.

Portio mollis.—Hearing is unimpaired.

Glossopharyngeus.—Vomiting reflex is in abeyance.

Vagus and accessorius vagi.—Paralysis of the abductors of the vocal cords. Paralysis of articulation. Paresis of the soft palate.

Hypoglossus.—Glossoplegia with wasting.

Spinal accessory.—Paresis, with wasting of sterno-mastoid muscles and upper parts of both trapezii.

Cervical nerves.—Paralysis of the muscles which move the head; paralysis of the diaphragm; atrophy of the infra-hyoid muscles.

Brachial plexus.—Paralysis and atrophy of the muscles of the right shoulder, arm, and hand; rigidity and increased tendon jerks; paresis and atrophy of the left arm and hand; paralysis of the right serratus magnus, paresis of the left; atrophy and paresis of both pectorales. No affection of sensation.

Dorsal nerves.—Paresis of the abdominal and back muscles.

Lumbar plexus.—Paralysis, atrophy, and rigidity of the muscles of the right leg; paresis of the left leg.

Sphincters.—Unaffected.

April 1st, 1889. *Exitus letalis.*

Autopsy.—Dura mater slightly adherent to calvarium; considerable opacity of the arachnoid over the hemispheres, but not over the base; no excess of cerebro-spinal fluid; no *naked eye* changes in brain or spinal cord.

Lungs, liver, and kidneys were of normal appearance.

Heart: slight, easily torn adhesions between epi- and pericardium.

The muscles were all of good colour, slightly soft, but not friable; they were all more or less atrophied. There was complete absence of subcutaneous fat. The platysma myoides were pale, but well developed on both sides.

MICROSCOPICAL EXAMINATION OF BRAIN, MEDULLA OBLONGATA, AND SPINAL CORD.

Vertical transverse sections of the brain were made at levels, which included part of the motor region, and carefully examined with a view to finding some alteration of the cortical cells, but no trustworthy results were obtained. Allowing for the influence of *post-mortem* decomposition, the appearance did not seem to differ much from the normal, but it was remarked that the cortex generally was very vascular.

The internal capsule is, unfortunately, affected by *post-mortem* softening in places, but those regions of it which have escaped seem to be natural.

The crura cerebri at the level of the third nucleus show signs of decomposition, which make it difficult to say whether, or not, there is any degeneration of fibres in the motor tract.

The third nucleus is not deficient in ganglion cells, though the cells themselves seem to be highly pigmented. The posterior longitudinal bundles are normal. Some sections were made of the upper pons, which showed marked degeneration of the pyramidal tracts, but not so complete as in the next section.

Unfortunately the region intervening between the last section and that at the level of the fifth nerve is missing, so that our next section is taken through the pons at the lowest level of the fifth nucleus. Here sections were made, which include the middle peduncle of the cerebellum, and, in fact, all the white matter of the cerebellum, and also the nucleus dentatus. The white fibres of the central parts of the section show the beaded appearance of *post-mortem*

decomposition, but the peripheral parts are in good histological preservation. Only the lowest part of the motor nucleus of the fifth nerve can be examined in these sections, and in it can be seen only two or three ganglion cells, but several carmine-stained patches indicating degenerated cells. What can be seen of the sensory nucleus is natural. The other nuclei to be seen in this section are the superior olive, the nucleus trapezoides, and the nucleus dentatus of the cerebellum, all of which appear to be natural. The condition of the pyramidal bundles is very striking. To the naked eye, after Weigert-Pal treatment, the pyramidal regions appear very lightly stained, while under the microscope there can be seen no normal large or medium medullated fibres, and much fewer than normal small fibres. It is possible that decomposition may be accountable for a certain amount of the myeline *débris* lying about, but the transversely crossing fibres, which are numerous, show little or no decomposition. Under a high power double stained sections of the pyramidal bundles show a loose granular ground substance, plentifully besprinkled with nuclei, a few rather large droplets of blue-staining myeline matter, and a number of small black dots indicating small medullated nerve fibres or their remains. In some parts the granular ground substance is more condensed, forming a true sclerosis, but this is more noticeable in the cord than in the medulla. We may say, therefore, that the whole of the pyramidal tract is completely degenerated on both sides. There appears to be no affection of the transverse fibres forming the trapezoid body so-called. The fillet appears to be unaffected by disease, but its fibres are much beaded by decomposition, owing to delayed penetration of the hardening reagent. The posterior longitudinal fibres present quite normal appearances.

The next section includes the nuclei of the sixth and seventh nerves, and the intra-medullary course of these nerves, and the eighth. The sixth nucleus, Fig. 1, VI. n., is perfectly natural in appearance. The fibres of the sixth nerve are also natural.

The seventh nucleus, VII. n., shows very few ganglion

cells, and these are abnormally rounded, atrophied or granular. The individual fibres of the seventh root in its course through the medulla seem to be quite natural, that is, none are to be seen in the process of degeneration, but the bundle, as a whole, is decidedly smaller than natural. On the other hand, the compact little bundle of transversely-cut medullated fibres, the ascending loop of the seventh Fig. I., VII. a., which is usually so conspicuous above the posterior longitudinal bundles, is here invisible by Weigert-Pal staining. On carefully examining it with higher power we find that normal nerve fibres are completely absent from it, and that it consists of loose meshwork of neuroglia and

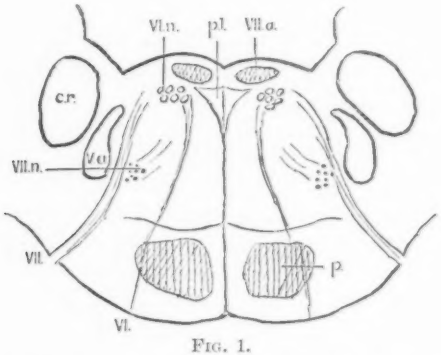

FIG. 1.

Diagram of lower pons, showing sixth and seventh nerves and nuclei, p. l., posterior longitudinal bundles, p. pyramidal tract, VII. n., seventh nucleus degenerated, VII. a., ascending loop of seventh root, VI. n., nucleus of sixth nerve, c.r., restiform body, V.a., ascending root of fifth nerve. In this and the succeeding diagrams, normal white and grey matter is drawn in outline without shading. Degenerated tracts are cross-hatched. Nerve nuclei containing healthy ganglion cells are represented by groups of small circles, those containing degenerated cells by groups of black dots.

nuclei. This taken with the much less atrophied condition of the issuing seventh root is remarkable, and will be considered further on. The degeneration of the pyramidal tracts is as in the preceding section.

At the junction of the pyramids with the pons the seventh nucleus is still visible, and at this level, though much affected, presents more nearly normal appearances than it

did higher up, that is, there are a few normal ganglion cells. The pyramidal tracts are totally degenerated, contrasting with the healthy arciform fibres surrounding them. The eighth nucleus and nerve are natural. The restiform body and the ascending root of the fifth and eighth nerves are here, as elsewhere, normal.

The next cranial nerve to be examined is the ninth. The nucleus seems to be perfectly natural, and the same may be said of the ascending root. At this level also the nucleus ambiguus, a group of cells lying on the inner side of the ascending root of the fifth, presents quite natural appearances, except for the pigmentation of its cells, which is so common an appearance that it can scarcely be considered pathological.

The freedom from disease of the nucleus ambiguus is important because this nucleus is evidently partly, if not entirely motor, by the character of its cells, and it is believed to be the motor nucleus of the vago-glossopharyngeal group. The nucleus centralis of Roller is natural.

In every case of bulbar paralysis the condition of the hypoglossal nucleus is of great interest, and here demands detailed examination.

When making sections backwards from the brain to the spinal cord, the normal hypoglossal nucleus begins to appear at just about the level of the most inferior striæ medullares. It is at first only indicated by a few large multipolar cells scattered among the small round cells which belong, probably, to the eighth and ninth nuclei on the one side, and to the nucleus funiculi teretis on the other. As we proceed spinal-wards, however, the nucleus becomes more and more defined, lying close under the floor of the fourth ventricle, and consisting exclusively of large multipolar ganglion cells. Ventrally to the nucleus pass out the fibres of the hypoglossal nerve and close under the nucleus among the root-fibres lies another diffuse collection of small cells, the small-celled nucleus of the hypoglossal (Roller). In well-stained sections there is a close network of medullated fibres all through the chief nucleus. In each section of the nucleus when at its fullest size may be counted from thirty to

forty ganglion cells, diminishing to about twenty at the level of the calamus scriptorius, and still further back to five or ten, that is, at the level of the lower or spinal extremity of the olive, just below which the nucleus disappears. The small-celled nucleus is most distinct in the cerebral or upper third of the chief nucleus, and becomes less marked as we go backwards till it disappears. It has several large cells scattered about in it.

Fig. 2 shows the relations of the nucleus in the medulla at a level at which it is usually best seen, that is, about its upper third. At the most cerebral end the nucleus contains a considerable number of normal cells. A little further back, however, this is not the case. Here, where there

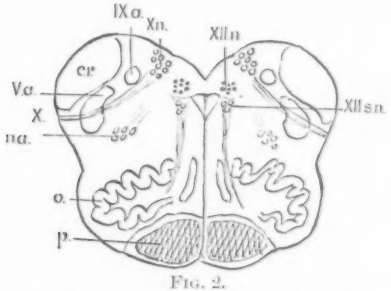

FIG. 2.

Medulla at middle olive, or lower part of floor of fourth ventricle, showing relative position of vagus and hypoglossal nuclei. IX.a. so-called ascending root of glossopharyngeal. X.n. vagus nucleus. XII.n. hypoglossal nucleus degenerated. O. olive. XII.s.n. so-called small-celled nucleus of hypoglossal (Roller) n.a. nucleus ambiguus. Other lettering as in Fig. 1.

should be counted from thirty to forty well-formed, large multipolar ganglion cells, there are to be found in some sections perhaps as many as ten at the most, generally four or five, and in some even none at all.

The ground substance of the normal nucleus should be fairly compact, finely granular neuroglia supporting numberless interlacing white fibres which come out very distinctly by Weigert-Pal staining. In the affected nucleus, however, the supporting tissue consists of a loose meshwork of fine fibrils with many nuclei. There are some white medullated

fibres but not so many as in the normal nucleus. The root bundles of the nerve contain decidedly fewer fibres than natural, in fact the hypoglossal roots are not the conspicuous objects that they are in sections of natural medulla oblongata.

The small-celled nucleus does not appear to be affected in any way, and among its cells may be found many normal large cells.

The vagus nucleus (X.n.) is normal.

Below the calamus scriptorius, where the central canal is completely surrounded by the central grey tube, the nucleus lying dorsally to the hypoglossal is that of the eleventh nerve or accessorius vagi. This nucleus is quite

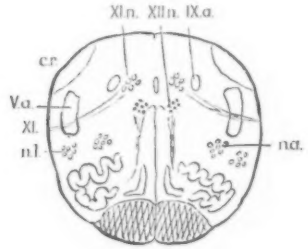

FIG. 3.

Medulla at lower olive below calamus scriptorius showing the relative position of accessorius and hypoglossal nuclei. XI.n. accessorius nucleus. n.l. Nucleus lateralis.

normal in appearance. The nucleus lateralis presents no sign of degeneration.

In the lowest part of the medulla (Fig. 4) just above the decussation, we find a great degeneration of the anterior horns (c.a.) which here first make their appearance. The hypoglossal nucleus is still visible and degenerated. The nucleus funiculi gracilis, and nucleus cuneatus internus (n.c.) and externus (seen in sections higher up than this) are quite natural. The pyramids at this level show considerable numbers of natural nerve fibres both large and small.

In the spinal cord at the first cervical nerve the grey

matter of the anterior horn is almost devoid of ganglion cells, in some of the sections none are to be seen at all, in others at most two or three. The lowest fibres of the anterior pyramids are still to be seen crossing to form the crossed pyramidal tract which is now seen to be distinctly affected. It contains very few large nerve fibres compared with the healthy cord, so that by Weigert-Pal staining it appears as a lightly-stained patch, but by carmine staining it comes out a dark patch owing to a slight condensation of the neuroglia.

At cervical ii., besides disappearance of ganglion cells, there is also marked wasting of the horns, rather more marked on the left side. The lateral horns share in this wasting. There are a few natural bipolar cells in the base

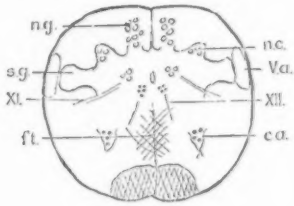

FIG. 4.

Medulla at level of first appearance of anterior horns of cord. c.a. Anterior horns, ganglion cells degenerated or absent. s.g. Substantia gelatinosa. n.c. Nucleus cuneatus internus. n.g. Nucleus funiculi gracilis. f.t. Decussation of fillet, natural.

of the posterior horn, the position taken lower down by the posterior vesicular column. The degeneration of the crossed pyramidal tract reaches to the periphery of the section in the region of the posterior horns. There is well marked affection of the anterior median column and the direct pyramidal tract.

At the level of cervical iv. (Fig. 5), the shrinking of the anterior horn brings into prominence the lateral horn, particularly on the left side. Here are a few cells, but there are the remains of many degenerated cells lying about.

There is still a very small strip of degeneration on each side of the anterior fissure (d.p.t.).

At cervical vii. the attenuation of the anterior horns is very marked, especially on the left side. The left lateral horn stands out in marked prominence, and is seen to contain many natural ganglion cells.

At dorsal ii. we have the first appearance in this series of the posterior vesicular column. This appears to be perfectly natural here and in all the sections below this level. The wasting of the anterior horns is slightly more pronounced on the left side. The crossed pyramidal tract is extensively affected, but it shows a fair sprinkling of normal large white nerve fibres scattered through it.

At dorsal vi. the wasting of the anterior horns is extreme. The degeneration of the crossed pyramidal tract now reaches the edge of this section. It has here the

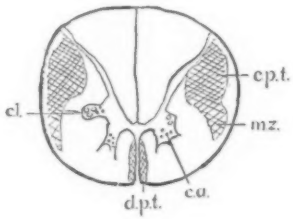

FIG. 5.

Transverse section of spinal cord at level of cervical iv.; c.p.t., crossed pyramidal tract degenerated; d.p.t., direct pyramidal tract degenerated; m.z., descending fibres in the "mixed zone" degenerated; c.l., lateral horn with some normal cells, but many degenerated.

appearance of a sclerosis, but has in it many quite normal large nerve fibres, many more than in the last section. These fibres are, many of them, probably ascending from the posterior vesicular column to gain the direct cerebellar tract.

At dorsal viii. (Fig. 6), the thinning of the anterior horns is, perhaps, at its maximum. In some of the sections a ganglion cell or two may be seen, but in others none at all. The posterior vesicular column is unaffected, contrasting strongly with the wasted anterior horns.

At lumbar i., though the anterior horns are smaller than

usual, they contain a considerable number of healthy ganglion cells. The sclerosis of the crossed pyramidal tract is most pronounced on the left side. The posterior vesicular column is fully developed and perfectly normal.

At lumbar iii. (Fig. 7), the grey matter presents more nearly normal appearances than in any of the preceding

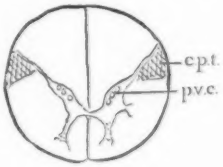

FIG. 6.

Transverse section of cord at level of dorsal viii.: p.v.c., posterior vesicular column.

sections, but even here the ganglion cells are below the normal in point of number.

The anterior root fibres proceeding from the anterior horns in all these sections appeared to be rather thin and to retain the Weigert-Pal staining badly. We hesitate, however, to pronounce this as a sign of atrophy of the fibres,

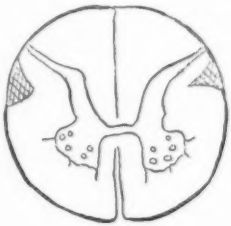

FIG. 7.

Transverse section of cord at level of lumbar iii.

because it is an appearance common in lightly stained sections of normal spinal cord. The transverse sections of the anterior roots themselves, which could be seen in most of the sections, were critically examined with absolutely negative results. It is difficult to believe that any considerable disappearance of white fibres could fail to be discovered in such a large number of sections.

Summary of Microscopical Appearances.

1. Motor cortex apparently normal.

2. White fibres of internal capsules and crura cerebri also normal.

3. Pyramidal tracts of upper and middle pons deeply degenerated, showing complete absence of white medullated fibres, and some condensation of neuroglia base.

4. Crossed pyramidal tracts both degenerated all the way down the cord, but from the decussation downwards there are some healthy white fibres scattered about in the sclerosed area.

The direct pyramidal tract is degenerated as far down as cervical iv.

5. Cranial nerve nuclei affected are:—

(*a*) Motor nucleus of fifth.

(*b*) Nucleus of seventh extensively, issuing roots attenuated only, but ascending loop deeply degenerated, being quite devoid of medullated nerve fibres.

(*c*) Hypoglossal nucleus extensively, roots much thinned.

6. Cranial and other nerve nuclei not affected by disease are those of the third (fourth not examined), sixth, seventh, ninth, tenth, eleventh, and small-celled nucleus of twelfth. Also nucleus dentatus, nucleus trapezoides, nucleus centralis, nucleus ambiguus, nucleus lateralis, nucleus arcuatus, nucleus funiculi teretis, olivary body, superior olive, nucleus funiculi gracilis, and nucleus cuneatus internus, and externus.

7. Grey matter of cord from cervical i. to lumbar i. shows extreme atrophy, with almost complete loss of ganglion cells, in the anterior horns especially, and to a very great extent in the lateral horns also. The issuing anterior root fibres appear rather thin, but the anterior roots outside the cord are normal.

8. The posterior vesicular column is everywhere normal.

The following points appear to us to be worthy of special remark:—

Distribution of disease in motor grey matter.—All the ganglionic cell groups innervating the somatic muscles, that is those nervous centres included in Dr. Hughlings Jackson's "lowest level," are deeply degenerated, with the exception of the oculo-motor nuclei, and those which control the sphincters ("escape of eyes and perinæum").

Distribution of disease in motor white matter.—There is intense degeneration of the pyramidal tracts in the middle pons, and to a lesser degree of the upper, but lower down, that is at the level of the olive, these tracts show considerable numbers of what may be healthy fibres, and also numbers of small medullated fibres. Below the decussation, the area of sclerosis differs in no respect from an ordinary descending secondary degeneration. The extension forwards of the degeneration into the region of the "mixed zone" is not due to diffuse myelitis, but as has been shown by one of us,[1] marks the normal position of certain of the descending motor fibres.

These facts suggest the possibility of the existence of a primary lesion of the pyramidal tracts in the pons with corresponding secondary descending lesions.

Condition of the peripheral nervous system.—As pointed out in the pathological report, though the ganglion cells of the anterior horns of the cord and medulla are deeply degenerated, yet the anterior nerve roots are perfectly healthy. On the other hand, the roots of the hypoglossal and facial nerves are very much thinned by the disappearance of many nerve fibres, particularly in the case of the former, but those which are present are natural in appearance. We can offer no explanation of this apparent anomaly.

Relation of facial nerve to seventh nucleus.—We are enabled by the microscopical examination of this case to produce anatomical evidence of the possible innervation of the orbicularis palpebrarum by the oculo-motor nuclei. As above described, the oculo-motor nuclei (third and sixth, fourth not examined) are quite healthy, while the seventh nucleus, and the ascending loop of the nerve (Fig. 1, vii. a.)

[1] *Tooth.*—Secondary degeneration of the spinal cord, 1889, p. 36. Figured also by Hadden and Sherrington in BRAIN, Vol. VIII. p. 502.

lying dorsally to the posterior longitudinal bundles are deeply degenerated. Now it is probable that this ascending limb includes all the fibres from the nucleus proper. But the nerve root, on the other hand, passing through the medulla to issue from the side as the seventh nerve, though not presenting the size and compactness of the normal root, yet contains many perfectly normal fibres. We must suppose that these have come from some other source than the highly degenerated nucleus, and we believe that they come from the oculo-motor nuclei by way of the posterior longitudinal bundles, and are passing in the trunk of the facial nerve to supply the unaffected muscles of the upper face, or, as we may call them, the oculo-facial group (frontalis, corrugator supercilii and orbicularis palpebrarum).

In support of this view we refer to a suggestive paper by Mendel,[1] who performed experiments after Gudden's method on rabbits and guinea pigs. The upper and lower eyelids were stitched together, and the frontalis extirpated, in newborn animals. After six to ten months they were killed. Careful examination of the abducens and seventh nuclei failed to show any change in them. The facial trunk on the side operated upon appeared thinner than on the other side. Marked changes were found in the hinder parts of the third nucleus, namely, great diminution in the number of the ganglion cells, so as to cause the nucleus, as a whole, to be much smaller on the same than on the opposite side. The cells were atrophied and their protoplasm stained less vigorously than normal. He suggests that the path of connection between the oculo-motor nuclei and the facial nerve is the posterior longitudinal bundle.

There is reason to suppose that another important set of fibres, which reach their destination by way of the facial nerve, namely, those which supply the orbicularis oris, have their nucleus of origin in other than the seventh nucleus, probably the hypoglossal. The clinical facts of all cases of bulbar paralysis lend support to this view; they all show

[1] *Mendel.—Ueber den Kernursprung des Augen-Facialis; Neurolog. Centralbl.*, 1887, p. 537. Mendel refers to a discussion on the subject in the *Berlin. Klin. Wochenschr.*, 1887, No. 48.

the very close relations which exist between the lips and the tongue. But in order to demonstrate the separation between the motor innervation of the lips from the other facial muscles, we refer to a case, mentioned by Dr. Gowers,[1] of poliomyelitis affecting the seventh nucleus only, where the orbicularis oris escaped. Our case does not add any anatomical evidence in solution of the problem as to how the fibres which supply the lips reach the facial nerve trunk from their nucleus of origin. The path is possibly the lower part of the posterior longitudinal bundles, but our case throws no light on this point.

Relation of eleventh nerve (accessorius vagi) to hypoglossal nucleus.—This nerve is usually described as consisting of two parts, that accessory to the vagus, accessorius vagi, or eleventh nerve, and a spinal division, or accessorius spinalis. About the latter we have nothing to say, its origin, distribution, and function being fairly clear. But as to the former we find very little information, even in the latest text books. According to Lockhart Clarke, and Schwalbe, the accessorius vagi nucleus is the lowest of the three nuclei contained in one cylinder of grey matter, which nuclei are from above downwards the glossopharyngeal or ninth, the vagus or tenth, and the accessorius vagi or eleventh. As it is impossible to differentiate the lower fibres of the vagus nerve roots from those of the accessorius vagi, as they issue from the medulla between the restiform body and the olive, except inferentially by their position, so no hard and fast line can be drawn between the nuclei of origin of these nerves. But for the purpose of description it may be convenient to state that so long as the central canal is surrounded by grey matter, the ganglionic cell group lying *dorsally* to the hypoglossal nucleus, may be regarded as that of the accessorius vagi. Where, however, the canal has opened out into the fourth ventricle, the cell group lying *externally* to the hypoglossal nucleus, and thus forming part of the floor of the ventricle, is that of the vagus. This, so far as we can make out from authors, is the present position of anatomical knowledge on the subject.

[1] Gowers' "Diseases of the Nervous System," 1888, vol. ii., p. 222.

In the case of V——n, we can say that the common nucleus of the ninth, tenth, and eleventh nerves is quite healthy. (This appears to be the condition in all recorded cases in which the state of the nucleus is specially noted, with one exception.[1]) This is at variance with the fact that he had paresis of the soft palate, and paralysis of the abductors, and adduction of the vocal cords, which muscles are regarded as being supplied through the vagus by its accessory branch. That the eleventh nerve is the path by which motor fibres reach the palate and vocal cords was long ago demonstrated clinically by Dr. Hughlings Jackson, and has been recently corroborated by experiments of stimulation and section of that nerve within the skull.[2] As we have just said, the eleventh nucleus was in our case healthy, we must therefore look elsewhere for the nucleus of origin of its motor fibres. The nucleus ambiguus from its position and connection would, at first sight, appear likely to be the motor nucleus in question, and indeed has been called by some writers (Obersteiner) the motor vago-glossopharyngeal nucleus. In the present case its cells, however, are perfectly healthy. By a process of exclusion, then, we are driven to localise the nucleus of origin of the motor fibres of the eleventh nerve in the sphere of the hypoglossal nucleus.

Anatomical evidence is hitherto wanting, but the clinical facts of nearly all cases of bulbar paralysis point to this conclusion.

Conclusions summarised.—1. Our conclusions with regard to the innervation of the facial muscles may be briefly summarised as follows, and are diagrammatically represented by Fig. 8.

The facial muscles may be divided into three divisions. First, the oculo-facial group, frontalis, orbicularis palpebrarum, and corrugator supercilii. Second, the middle group, elevators and depressors of the angle of the mouth, zygomatics, risorius, and buccinators. Third, the oro-facial

[1] Kronthal, *op. cit.*
[2] Beevor and Horsley, *Proc. Roy. Soc.*, vol. xliv., 1888.

group, or orbicularis oris. All these muscles are innervated by fibres included in the facial trunk, and are all paralysed, when the *nerve* is affected, as is shown by any ordinary case of Bell's paralysis. When, however, the facial nucleus only is diseased there results paralysis of the middle group only.[1] The upper group is paralysed when the oculo-motor nucleus is affected, the course of the fibres being probably the posterior longitudinal bundle.[2]

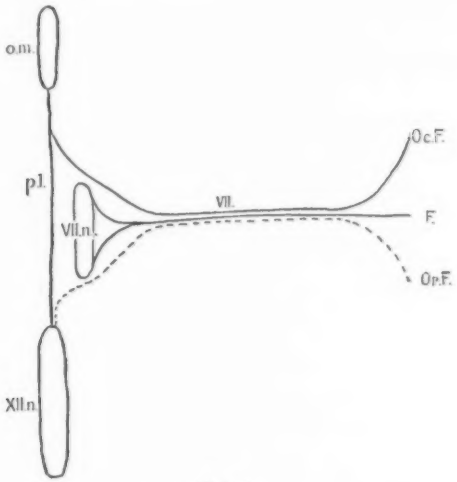

FIG. 8.

Diagram showing the origin and distribution of the fibres contained in the facial nerve trunk; o.m., oculo-motor nucleus including for diagrammatic purposes, the third, fourth, and sixth nuclei; p.l., posterior longitudinal bundle conveying fibres from the oculo-motor nucleus to Oc.F., the oculo-facial group; VII.n., the nucleus of the seventh nerve supplying fibres to F., the middle facial and lower muscles of expression; XII.n., the hypoglossal nucleus supplying fibres to Or.F., the oro-facial, or lip muscles represented by a broken line.

Paralysis of the orbicularis oris is associated with that of the hypoglossal group of muscles, and is therefore presumably innervated by that nucleus. The course of the fibres is at

[1] Gowers, *Loc. cit.*

[2] We have reason to suspect that in total nuclear ophthalmoplegia this does occur. See also a case mentioned by Uhthoff, *Berl. Klin. Wochenschr.*, 1887, p. 913.

present obscure, but is possibly again the posterior longitudinal bundle.

2. The eleventh nerve or accessorius vagi is known to contain motor fibres for the palate and vocal cords. The apparent nucleus of this nerve is indistinguishable from that of the vagus with which it is continuous. Its nerve roots may be regarded as the lowest fibres of the vagus, and its nucleus as the lowest part of the vagus nucleus. Its motor fibres which innervate the palate and larynx are, in all probability, derived from the region of the hypoglossal nucleus.

ON HEMISECTION OF THE SPINAL CORD.

BY WILLIAM ALDREN TURNER, M.B.EDIN., M.R.C.P.LOND.

SOME doubt has been recently[1] thrown upon the method of transmission of sensory impressions by the spinal cord, long ago enunciated by Brown-Séquard.[2] The conclusion, that all sensory fibres, with the exception of those subserving the muscular sense, decussated and passed up the opposite side, immediately or shortly after their entrance into the cord, was based on the records of clinical cases and on experiments made on guinea-pigs. Our intention here is to pass in review the whole series of recorded cases of "Brown-Séquard's paralysis" amounting to nearly 60 and to add a series of original experiments on monkeys, undertaken with the two-fold object; (1) to explain, if possible, the apparent discrepancies between the results obtained by the earlier observers and those more recently recorded; and (2) to ascertain the duration of the symptoms which might primarily result from hemisection of the spinal cord;—a point of very great importance in connection with the question of restitution of function.

The experiments were performed in the Neuro-Pathological laboratory of King's College. The facts of experiment here recorded were for the most part verified by Professor Ferrier.

1. *Clinical.*

It has been found necessary at the outset to divide the recorded cases of this paralysis into two great divisions; (1) those which were observed and recorded immediately

[1] Dr. F. W. Mott, *Proc. Physiol. Soc.*, January, 1891.
[2] Brown-Séquard, *Journal de la Physiologie*, vol. vi., and *Lancet* ii., 1868.

after, or within a short time of the injury or onset of the disease; (2) Those which were not carefully observed until months or years after the onset of the symptoms. That this division has been rendered essential will be seen from what follows, but the statement may be made now, that the presence of a set of symptoms at any given time is no evidence of their existence either a short time previous or later on; a constant tendency to the restitution of the functions of the injured portion of the spinal cord occurring in those parts which remain intact.

1. *Cases which were observed immediately after or within a short time of the onset of the symptoms.*[1]

Tactile sensibility.—In all the cases, which have been collected, the sense of touch was present on the paralysed side. In the great majority there was hyperæsthesia of this as well as of the other forms of sensation; in several it is simply stated that all forms of sensation were preserved; but in three (Nos. 9, 14, 22[2]) it is definitely noted that the sensibility to touch was normal, while pain and temperature were augmented. In the major number of the cases this state obtained both in the paralysed leg, as well as in the paralysed arm, when the lesion was situated in the upper cervical region. On the non-paralysed side or side opposite to the lesion one finds that in the greater number there is complete anæsthesia of all forms of sensation; in a few the sensibility is defective; in No. 39 (Gowers' case) there was no loss of tactile sensibility and only incomplete analgesia. In No. 42 although there was analgesia, the sensibility to touch was merely lessened; In 13, 55 and 56 tactile sensibility was only defective, while in 44 and 53 it was retained. In No. 52, the paralysed leg presented a hyperæsthesic condition, while the paralysed arm showed "loss of feeling"; the non-paralysed leg was anæsthetic, the corresponding arm being normal as regards both motion and sensation.

Sensibility to pain (pricking and pinching).—What has been said with regard to touch, holds good for pain on the

[1] Cases of tumor of the spinal cord have, for obvious reasons, been left out of the collection.

[2] The numbers refer to the list of cases at the end of the paper.

paralysed side. As a rule there is hyperæsthesia of painful impressions. In No. 9, pain and temperature impressions were augmented, while touch was normal: in No. 14, pain only was increased. On the side opposite the lesion there is analgesia; in No. 13, there was analgesia and thermoanæsthesia, the sense of touch being only diminished: in No. 39, there was defective sense of pain without any affection of tactile sensibility; and in No. 56 with defective sense of touch and pain, there was loss of the sense of temperature. In No. 30, there was blunting of the sensibilities of pain and heat, the sense of touch being unaffected.

Temperature sense.—This behaves in most cases as the other forms of sensibility, *i.e.*, increased on the paralysed side, and lost or diminished on the side opposite the lesion. But amongst the recorded cases there are several well-marked instances where this form of sensibility dissociated itself from the others. In Nos. 55 and 56 there was thermoanæsthesia on the non-paralysed side, existing with defective pain and tactile sensibilities. No. 55 is especially important, for the patient was seen two and a half years later, and although the other forms had to some extent been restored, there was still complete loss of temperature sense on the side opposite the lesion.

The sense of localisation.—Brown-Séquard's conception was that there existed perfect knowledge of the localisation of impressions on the paralysed and hyperæsthetic limb, while there was loss or great diminution of this faculty on the anæsthetic side. The collected cases appear to corroborate this view.

The muscular sense.—On this point there is more diversity of opinion, than on any one of those previously considered. Brown-Séquard believed that this sense (the sense of detecting difference of weights, or of telling the position of the limbs without the aid of sight) was in abeyance on the paralysed side; but Dr. Ferrier (BRAIN, vol. 7, p. 1) showed, as a result of hemisection of the spinal cord of a monkey, that the sense of position of the limb appeared absent, not on the paralysed but on the opposite side (viz. that on which there was cutaneous anæsthesia). In several

of the collected cases no mention is made of this condition, while in others the only tests employed were those of "directing movements" or "perceiving strong pressure." It is therefore necessary, when noting the presence or absence of the muscular sense, to observe the sensibility of the skin to tactile impressions. In Nos. 11, 13, 15, 21, 53 and 57, the muscular sense was present on the apparently anæsthetic side, but on this side there was no loss of tactile sensibility. In Nos. 26 and 45 it was lost on the anæsthetic side, in the latter it is especially stated that the patient was unable to tell when the eyes were closed, the position of the toes, foot, or lower part of the leg, over which parts there was complete tactile anæsthesia. There was some uncertainty of the muscular sense on the paretic side in No. 54, but here the tactile sensibility was defective.

2. *The cases which were observed months or years after the onset of the symptoms.*

In a case recorded 3 months after the onset of the symptoms (No. 48) there was paralysis on the side of the lesion; and on the opposite side, defective sensibility to touch and tickling, with analgesia and thermoanæsthesia. In several seen six months after, both the amount of paralysis and the condition of the sensibility varied. In No. 40 there was on one side paresis with normal sensibility, and on the other anæsthesia of all forms of sensation. In No. 49, on the opposite side the sense of contact was defective, while that of pain and temperature were entirely lost. In No. 50 a weakness in the finer movements summed up the motor defect, while pain and temperature sensibilities were in complete abeyance on the opposite side. In No. 52, with paresis of arm and leg on one side, there was on the opposite side defective sensibility in the leg, while the arm was normal. In one seen twelve months after onset (No. 45) there existed paresis of one side with defective sensibilities on the other. In No. 55, which was seen two and a half years after the first observation, all forms of sensibility had returned in the leg with the exception of pain and temperature. No. 16 was seen three years after the onset and slight hyperæsthesia still existed on the paralysed side, and on

the opposite side, although touch was present, there was analgesia. In two of Brown-Séquard's cases (Nos. 3 and 20) observed eleven and twenty-one years after a stab in the back, and a fall off a staircase respectively, hyperæsthesia existed on the paralysed side, which was also rigid, and on the other side all forms of sensation were abolished except tactile sensibility which was defective. On the other hand in a case seen twelve years after a similar injury (No. 53) on one side there was defective movement with normal sensibility, on the other touch, pain and temperature senses were only diminished.

It is necessary further to study with some detail those cases in which the lesion was situated in the cervical region of the spinal cord. Of the sixty collected cases, specific mention is made of the arms and legs in seventeen. Of these, thirteen show the usual appearance of "Brown-Séquard's paralysis" in both upper and lower limbs; the remaining four are of great interest when taken in conjunction with the experiments on monkeys shortly to be detailed. In case No. 3 (Brown-Séquard), as a result of a stab high up in the neck, a patient developed paralysis of the right arm and leg. On the paralysed leg there was hyperæsthesia of all forms of sensation, while on the non-paralysed there was defective tactile sensibility, analgesia and thermo-anæsthesia. On the right or paralysed hand, the two points of the æsthesiometer were recognised at 2-3 c.m., while the upper arm was anæsthetic, the senses of tickling, pain and temperature were exaggerated. On the non-paralysed limb there was more or less anæsthesia to all forms. In No. 6 (Perroud, quoted by Brown-Séquard) the "sense of contact" is stated to be diminished on the paralysed forearm, but no mention is made of the sensibility of the other arm. In No. 7 (Brown-Séquard), paralysis of the right arm and leg resulted from a stab in the neck. In the lower limbs there obtained paralysis with hyperæsthesia on one side, anæsthesia on the opposite side, while there was incomplete anæsthesia on both arms. Lastly in case 52 (Hoffman) the following condition was observed: Paralysis of the right leg with hyperæsthesia, paresis of the right arm with "loss

of feeling"; anæsthesia of the right leg, while in the left arm "motion and sensation were good."

Among other facts in connection with the collected cases may be mentioned:—The organic functions are as a rule disturbed for a short period after the injury to the spinal cord, in the majority of cases incontinence of urine and fæces lasted from ten days to a fortnight. In a few cases constipation was present. The bilaterally associated movements of respiration are not affected, the two sides of the chest moving equally immediately after the lesion: In No. 52 paresis of the diaphragm on the side of the motor paralysis was noted, while in Nos. 46 and 54 special note is made of the fact that the abdominal muscles on the side of the lesion were paralysed. The condition of the reflexes calls for special mention. In nearly all the earlier cases recorded by Brown-Séquard and others, the superficial reflexes, especially the plantar, were observed to be augmented on the non-paralysed side, while in the later cases the condition of the knee jerk was noted. Immediately after the injury the knee jerk is absent or diminished on the paralysed side and normal on the opposite side. During the progress of the case, it returns and in course of time becomes somewhat exaggerated.

Before leaving the discussion of the recorded cases of this paralysis, it should be noted that only in a very few instances a *post-mortem* examination was obtained.[1]

It is, therefore, impossible to say whether in the majority of cases the lesion was a truly unilateral one or not. But arguing from the facts of experiments it appears probable that the major portion were of this one-sided character.

2. *Experimental.*

Before detailing the experiments, the methods of operation will be mentioned. Monkeys were used in every case, and the operation itself was regarded as a surgical procedure under strictly antiseptic precautions; in all cases the wound healed by the first intention. Chloro-

[1] These are Nos. 25, 27, 29, 39, and 46.

form was the anæsthetic employed. The vertebral spines and laminæ were exposed in the usual way, and the canal opened into with the bone forceps. The theca was incised mesially, and at either end of this incision two oblique cuts were made outwards, so as to expose the entrance of the posterior nerve roots on either side. The posterior median fissure is usually obscured by a blood-vessel. This having been moved to one or other side, a grooved transfixion knife was passed through the cord in the middle line of the body, and one-half of the cord severed. The wound was then closed.

Experiments on animals made with a view to investigate conditions of sensation are beset with fallacies, and the symptoms may be differently interpreted. We have, therefore, in detailing the experiments, noted what we saw. The two chief difficulties which stand in the way of this method are—(1) Complications arising from reflex action. It is pointed out that this is excessive in the lower limb on the side opposite the lesion; in some of the cases a drop of water or a breath of cold air on the non-paralysed foot setting up active movements of the leg. (2) As one can only infer the presence of sensation by the movements which occur, it is possible sensation may exist not evidenced by movements. In a few of the cases on the day following the operation, it was difficult to ascertain definitely the presence of a sense of touch owing to slight apathy, but after the first twenty-four or thirty hours the animal assumed its normal state.

EXPERIMENT 1.—*A section of the right side of the spinal cord at the level of the ninth dorsal nerve root* was made on April 11th, 1891. A well-conditioned male Rhœsus monkey was used. On the day following the operation, which is regarded as the *first* day of observation, and when all appearance of shock had passed off, the following condition was noted:—There was complete paralysis of the right lower limb, while the left, although it was freely moved when the animal lay upon its back and tried to escape, was not used for prehension when climbing the lattice-work of the cage. Its attention was at once arrested by ruffling the hair, pricking, pinching, and the application of a dull hot

wire to the skin of the right lower limb, while it paid absolutely no heed to any of these forms of stimulation on the left. There was no reason to suppose from the manner in which it responded to the various forms of irritation that they were felt more keenly than normal. The right foot felt warmer than the left, while a surface thermometer recorded on the sole a difference of 16° F. between the two (right sole 86° F., left sole 70° F.). The right knee-jerk was not obtained, while the left was more marked than normal. The superficial reflexes, especially the plantar, were much more active on the left or non-paralysed limb. This condition remained until the *third day*, when, on touching the region of the left knee with the hot wire, the monkey would bring down its hand and scratch, but never struggle or show signs of discomfort. On the *fifth day* when pricked with a pin about the left knee, but much more evident when the hot wire was applied to the limb generally, it brought its hand down to the place touched and localised it. It took no notice of ruffling the hair on this side. The reaction to cutaneous irritation of the right side remained as before. On the *tenth day* the physical signs corresponded to those in the last note; it was evident that painful impressions were perceived, but much less readily than on the right limb. By the *twenty-fourth day* the power of flexing the right hip joint had returned. For the first time, the "clamp test" (Schiff) was introduced into the routine of testing, and this revealed interesting facts not altogether easy of interpretation. It was noted that when the clamp was applied to the right leg, struggling and other signs of discomfort immediately ensued, but there was no attempt to remove it, while if it was applied to the left leg, there was no sign of discomfort, but the leg was at once drawn up and the clamp was pulled off. It seemed as if the cause of this was the excessive reflex action of the non-paralysed side; to overcome this the legs were held, and the clamp again applied to the right leg; at once the struggling commenced, and continued until the clamp was withdrawn, while the monkey took absolutely no notice as long as the clamp was attached to the left side. On freeing the legs, however, the left was

drawn up and the clamp pulled off. The temperature of the soles was the same. This doubtful condition remained for some days, but on the *thirty-eighth day* the following state was noted:—There is considerable return of the movements of the right leg, flexion and extension at the hip and knee joints being well effected. The left leg is now used much more extensively than before. The animal takes no notice of the pinching with forceps on the left side, but brings its hand down in an indefinite way when pricked gently at the root of the tail and the lower part of the back, and an equal degree of pricking causes more discomfort on the right than on the left side. When the animal's attention is diverted, ruffling the hair by blowing through a long glass tube invariably causes it to scratch. It does not take so much notice of the dull hot wire on the left as on the right side. The reactions to the clamp remain the same. On the *fifty-third day* the movements of the right leg had almost entirely returned, a slight drop-foot only indicating what had been a paralysed leg. There was also some wasting of the muscles of this limb. It took notice of pricking and pinching and ruffling the hair on the left leg as it did on the right. From this date onwards it was impossible to say which had been the anæsthetic limb; it responded as readily to all forms of stimulation on the one side as on the other.

On the *sixty-eighth day* (June 23rd, 1891) after the section of the right side of the cord, *a section of the left side at the level of the sixth dorsal nerve root was made.* The result of this was complete paralysis of both lower limbs, and complete anæsthesia of both limbs. It paid no attention to any forms of stimulation when applied to the legs, but readily when applied to the arms. The superficial reflexes on the right side now became markedly exaggerated. From this date onwards to the *one hundred and thirteenth day* after the original operation, when it was killed under an anæsthetic, the monkey showed no signs of returning motion or sensation. Both lower limbs became contracted and rigid and atrophied, the knee-jerks were active, the right remaining more marked than the left, and the superficial reflexes were also active.

Pathological examination.—At the seat of both incisions the dura mater was adherent to the surrounding bone, the membrane itself being slightly thickened. The spinal cord was removed and hardened in Müller's fluid. After some weeks, sections were made at the seat of both lesions, and double-stained with the Weigert-Pal and Carmine (Upson's) methods. In the first lesion, at the level of the ninth dorsal nerve, the following features were observed:—The incision was filled in by a layer of white fibrous tissue, which extended from the periphery to the line of the central canal. The whole of the right side of the cord had been destroyed, but in addition a small portion of the left postero-median

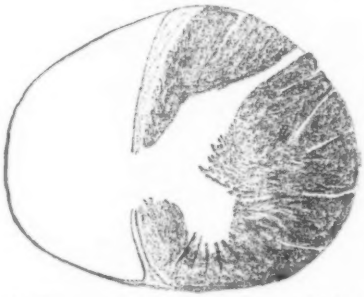

FIG. 1. (Exp. 1.) Representation of a section made through the lesion at the level of the ninth dorsal nerve roots. The unshaded portion of the section is the right side of the spinal cord. The anterior and posterior median septa are represented. The degeneration of the white matter on the left side of the cord is probably of "traumatic" origin.

column. The central grey matter on the left side maintained its normal shape, but its structure appeared slightly altered, owing probably to a certain amount of "traumatic degeneration," which had also increased the neuroglia of the white matter lying in close relation to it. At the sixth dorsal root, where the second hemisection was made, the right half of the spinal cord was intact, with the exception of the ascending degeneration, resulting from the lower lesion. The incision had not been filled in with new tissue, but remnants of very much degenerated cord substance were found in front and behind.

EXPERIMENT 2.—*Section of the spinal cord on the left*

side at the level of the seventh dorsal nerve root was made in a female Rhesus monkey, June 10th, 1891. The animal recovered very rapidly from the operation, and presented the following features:—Complete paralysis and flaccidity of the left lower extremity, while the right was moved well in all directions; although, as occurred in the first experiment, the non-paralysed leg was not used for any useful purpose, as, for instance, when it was climbing the lattice-work of the cage. This was, no doubt, due to the fact that owing to the cutaneous anæsthesia, the sense of the position of the limb was lost, and, without the aid of vision, it did not know where its right leg was. When the skin of the left leg was tickled, scraped with a blunt instrument, or gently pricked and pinched, its hand was at once brought down accurately to the place which was irritated. Absolutely no notice was taken of any of those forms of irritation when applied to the right lower limb. The superficial reflexes on the right side were markedly exaggerated. The paralysed limb further communicated a feeling of greater warmth to the hand than the non-paralysed. By the *sixth day* the monkey localised correctly the places on the right leg where it was pricked, or when the skin was tickled by blowing upon it, but it never struggled or showed signs of discomfort. Similar reactions to the clamp test ensued in this case to those observed in the first experiment. When the clamp was applied to the left side, the animal invariably struggled, and appeared annoyed by the presence of the clamp, but never tried to remove it. On the right leg, however, it never showed the slightest sign of any discomfort, even when the clamp was kept applied for several minutes; it was only necessary to free the limb which was being held, when the leg was drawn up and the clamp removed.

During the succeeding weeks, when the animal was under observation, the responses to the tests showed little or no variation from what is stated above. All forms of irritation, including the clamp test, arrested its attention when applied to the left leg; on the right leg, however, although pricking, pinching, and the hot wire usually attracted notice, the response was obtuse, and a greater

severity of stimulation was required. Return of movement was first noticed at the left hip-joint on the *twenty-second day*, and this proceeded until between the *fiftieth and sixtieth days;* movements had entirely returned, with the persistence, however, of slight drop-foot. The monkey was killed upon the one hundred and twenty-seventh day after the operation.

At the *autopsy*, the hemisection was found to be at the level of the seventh dorsal nerve root. After hardening the cord for some weeks in Müller's fluid, sections were cut and stained by the Weigert-Pal method. Sections made at the level of the lesion showed that the whole of the left half of the cord had been destroyed, and to some extent also the

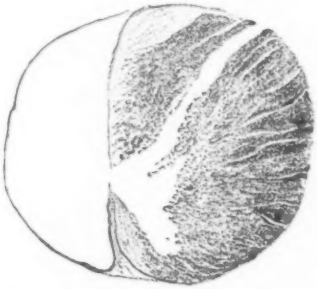

FIG. 2. (Exp. 2.) Section through the lesion at the level of the seventh dorsal nerve roots. The unshaded portion of the figure represents the left side of the spinal cord. The degeneration on the right side of the middle line is probably of "traumatic" nature.

anterior and posterior median columns on the right side. The space intervening between the cut ends of the left side of the cord was filled with white fibrous tissue, in which there was no evidence of regenerating nerve fibres.

These two experiments may be regarded as presenting the characteristic features of hemisection of the spinal cord in the mid-dorsal region. For a few days after the infliction of the injury, *all forms of sensation are lost on the side opposite the lesion*, while on the paralysed side all forms are preserved. After three to six days sensibility begins to return on the anæsthetic side. The first experiment showed that

the order of return was sense of pain (heat) on the third day, sense of pain (pricking and pinching) on the fifth, while in the second all forms, pain (heat), pain (pricking and pinching) and touch had returned simultaneously by the sixth day. There exists some doubt concerning the late return of the sense of touch in the first experiment. Our notes indicate that for many days much dubiety existed regarding the sensibility of the non-paralysed leg, so that it is not improbable that the sense of touch returned considerably earlier than is noted here. A certain obtuseness of sensibility obtains for some time after its restitution; the monkey withstands severe forms of irritation on the side opposite the lesion.

In both the experiments, movement at the hip-joint on the paralysed side was observed between the twentieth and the twenty-fourth days; at the knee-joint between the thirtieth and fortieth days; while dorsiflexion of the ankle remained in abeyance for a long time.

EXPERIMENT 3.—*A section of the left side of the spinal cord of a male bonnet monkey* was made between *the third and fourth cervical nerves* on May 26th, 1891. On the day following the operation one observed, that there was complete paralysis of the left arm and leg; as regards the sensation, (1) of the lower limbs; the animal paid no attention when it was touched on either leg, but it was dull and apathetic; it however readily responded by bringing its hand down to the place when it was pricked, pinched or touched with a dull hot wire on the left leg. No such response was evoked when the right lower limb was similarly irritated. (2) Of the arms; all forms of irritation except ruffling the hair at once arrested its attention when applied to the right upper limb; but there was considerable difficulty in determining the exact condition of the left. It took no notice of ruffling the hair by blowing through a glass tube or of gently scraping the surface of the skin with a blunt instrument, while it would struggle slightly or open its eyes when this limb was pinched, pricked or touched with a hot wire. Owing to its apathetic state it was difficult to estimate the sensibility to touch on the extremities; the sensibility to pain and heat

resolved itself as follows: analgesia of the non-paralysed leg, obtuseness of sensibility on the paralysed arm, while the paralysed leg and the non-paralysed arm presented normal reactions; there was no reason to suspect that there was any hyperæsthesia on these limbs. Tickling the sole of the right foot occasioned a lively reflex drawing up of the leg. The temperature of the left sole was 5° F. higher than the right. The right arm and leg were freely moved.

On the *seventh* day there was no sign of any return of movement in either limb on the left side, but when the hair on the right buttock and thigh was gently pulled or the skin lightly scraped or pricked, the animal at once brought down its right hand and scratched the place which was irritated. It was several times seen to spontaneously scratch the right thigh. And further, pricking the right foot and leg caused it to move away or, if held, to struggle. The same notice was taken when the left arm was pricked, but to a much less extent and the prick required to be more forcible. It was able to climb the lattice work entirely by means of its right arm and leg. On the *thirteenth* day, the first return of movement was noticed—flexion at the left hip joint; it responded to all forms of irritation (touch, pain, heat) in the left leg and the right arm and the right leg; much difficulty was experienced in ascertaining the sensibility of the left arm; the monkey was never aroused from its occupation when the arm was touched, but when pricked or when the hair was pulled it looked up but did not show signs of discomfort. On the *twenty-ninth* day the movements of the left leg were well marked at the hip and knee joints; the monkey readily took notice of all forms of stimulations on the legs. As in the first experiment the clamp was removed from the right leg, but never from the left. It was still difficult to determine the tactile sensibility of the left arm, it responded to painful impressions, but less readily than on the right side. By the *fifty-fifth* day some power of movement over the shoulder joint had been regained, while the increase in motor power of the left leg had advanced. There seemed to be no doubt that touching the left arm and hand or very gently pulling the hairs were felt, because the animal

invariably looked round and moved away, when this was done. Its perception of tactile impressions on this limb was distinctly blunted, as also was its perception of painful impressions. On the *one hundred and sixth day* the note was made that there was almost complete return of the movements of the left leg; the left arm was still paretic; it could not raise the elbow higher than the shoulder and there was marked wrist-drop. The sensibility remained the same as at the last note. The monkey died on the one hundred and twenty-sixth day after the operation.

Pathological examination.—Owing to a considerable amount of adhesion between the spinal cord, dura mater and

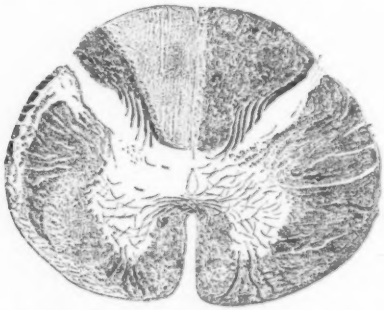

FIG. 3. (Exp. 3.) Transverse section of the spinal cord at the level of the second cervical nerve root, showing ascending degenerations following a section of the left side of the cord between the third and fourth cervical nerves.

vertebral column in the upper cervical region, some difficulty was experienced in removing the cord, with the result that the latter was torn at the seat of the lesion, so that we are unable to figure the exact amount of destruction of the cord. Careful examination has been made of the ascending and descending degenerations. The tracts which degenerate upwards are, on the left side, the whole of Goll's column, the direct cerebellar tract, and the ascending antero-lateral tract of Gowers. On the right side of the posterior median fissure there is a small linear area of degeneration in the postero-median column. The descending degenerations are the crossed and direct pyramidal tracts on the left side, and

a small portion of the direct pyramidal tract on the right side. The lesion itself was situated between the third and fourth cervical nerves on the left side.

EXPERIMENT 4.—*A section of the left side of the spinal cord at the level of the third cervical nerve* was made on Nov. 3rd, 1891. A large male Rhœsus monkey was used. On the day after the operation the state of motion and sensation was as follows: The left arm and leg were completely paralysed, while the right were freely moved at all the joints. All forms of cutaneous irritation applied to the left leg, buttock and flank (gently ruffling the hair, scraping the surface of the skin, pulling the hair, pricking, pinching, and the dull hot

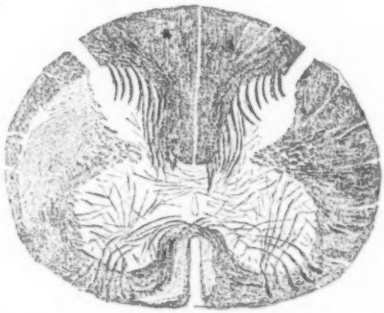

FIG. 4. (Exp. 3.) Transverse section of the spinal cord at the level of the seventh cervical nerve, showing degenerations descending from a section of the left side between the third and fourth cervical nerves.

wire) at once arrested the animal's attention. When the clamp was applied to the sole of the left foot or to the skin of the leg, struggling at once ensued, but there was never any attempt to remove it, and this continued as long as the clamp remained attached. Absolutely no notice was taken of any of these forms of irritation on the right leg, buttock or flank, but when the clamp was attached to the right sole, the leg (unless held) was speedily drawn up and the clamp pulled off. Pricking, pinching, and the clamp forceps gave rise only to slight signs of discomfort when applied to the right upper limb, while the monkey struggled considerably when the left arm was pricked or pinched or touched with

the hot wire. It paid no heed to gently scraping the skin or ruffling the hair of this limb, although its attention was at once arrested when a drop of water was allowed to fall upon either hand. It struggled when the clamp was applied to both hands, but less on the right than on the left side. It never tried to remove the forceps from the left hand. The right knee jerk was well marked, the left was present but feeble. The superficial reflexes on the right side were very active.

On the *second* day the monkey again removed the clamp from the right sole, but there was no evidence of any discomfort when it was applied. It never attempted to remove the clamp from the left sole, although it struggled as long as the pressure of the clamp was kept up. In all other respects, it remained as on the previous day.

On the *fourth* day, the reactions were as at the previous observations, but with this addition that pricking the right leg or right root of the tail would occasion a slight amount of struggling, as if there were some, but defective, perception of painful impression.

On the *fifth* day the monkey died.

The autopsy revealed a hemisection of the spinal cord at the level of the third cervical nerve.

EXPERIMENT 5.—*Section of the left side of the spinal cord at the level of the fourth cervical nerve.* The section was made on November 17th, 1891.

On the following day there was paralysis of the left leg and almost complete paralysis of the left arm, a slight movement at the shoulder joint being occasionally observed. Absolutely no notice was taken of any form of irritation applied to the right lower limb; when the clamp forceps was applied to the sole of the foot or elsewhere on the leg, a sudden spasmodic movement ensued of probably reflex nature, but the clamp was never removed, nor was there any attempt at removal. Similar forms of irritation on the left lower limb caused struggling and attempts to move away; and on the application of the forceps evident signs of discomfort, but no endeavour to remove it. The monkey bore, with only a small amount of struggling, pricking and

pinching the right upper limb, but at once responded to a touch either of a blunt instrument or of a drop of water let fall upon its hand. It at once took notice of pricking and pinching the left upper limb and also when the clamp was applied, but we were unable to detect at first any evidence of a sense of contact on this limb, as the monkey paid no attention to ruffling the hair or dropping water on its left hand. The superficial reflexes of the right lower limb were very marked, and the right knee jerk was readily obtained. The left knee jerk although present was feeble. The temperature of the right sole was 86° F, while the left was 94° F, that of the right palm was 84° F, while the left was 94° F. On the *second* day similar tests were employed, but no alteration was noted in the condition of sensation ; special attention was devoted to the tactile sensibility of the left hand, but no evidence of any recognition of tactile impression was obtained. On the *third* day, however, when the monkey was lying quietly before the fire, a drop of water let fall upon its left hand at once arrested its attention. The right leg remained completely anæsthetic to all forms of irritation. There was no sign of discomfort when the clamp was applied to the limb, nor was there any attempt to remove it. The right arm and left leg remained as before This condition was confirmed daily until the *eighth* day, when on applying the forceps to the left arm, the monkey brought round its right hand and tried to remove them, and, further, when water was dropped upon the left hand or when the arm was gently scraped, it looked towards its hand, and attempted to move away from the irritation. This was the first indication of something more than a mere feeling of contact on the paralysed arm. The right leg remained completely anæsthetic to all forms of irritation. There was some increase in the amount of movement noted on the first day, but the animal was yet unable to stand or sit up. On the *sixteenth day* the right leg remained completely anæsthetic to all stimulation, excepting that when pricked at the root of the tail on the right side, and when the skin of this region was blown upon, the monkey brought its hand round to the place and scratched it.

There was no attempt to remove the forceps from the right foot; although it could sit up, it was unable to progress. It at once responded when touched on the arms and the left leg: pricking the right arm caused less evidence of discomfort than when the left arm and leg were similarly irritated. On the *twentieth day* the condition remained as recorded in the last note.

The three experiments just recorded of hemisection in the upper cervical region present some variations in the amount of sensory disturbance. The condition obtained in the third experiment was opposed to previously recorded facts, and as the monkey was a troublesome one to test, the other two experiments (Nos. 4 and 5) were performed. These latter presented symptoms more in harmony with what occurred after hemisection in the dorsal region. On the arm opposite the lesion, the sense of pain was abolished or defective, but contact was retained. On the paralysed arm all forms of sensibility (pain and contact) were present, at any rate within a short time after the operation. These experiments also indicate variations in the duration of the symptoms and in the occurrence of restitution. In the third experiment sensibility had returned in the lower limb opposite the lesion by the seventh day after the operation. In the fourth experiment evidence of the return of painful sensibility was obtained on the fourth day. In the fifth experiment the lower limb opposite the lesion remained completely anæsthetic to all forms of irritation up till the twentieth day. The sense of pain on the non-paralysed arm remained very defective.

The Sensory Disturbances.

These experiments confirm the theory, which was originally advanced by Brown-Séquard, that the sensory fibres decussate immediately after, or within a short distance of, their entrance into the spinal cord and pass up the opposite side, while the motor fibres pass down the same side of the cord. This, however, appears to be only true of the sensory fibres for the lower, or hinder extremities. As far as our experiments show, a modification of this arrangement is

necessary for the upper or fore-limbs. That complete decussation of the sensory fibres from the arms occurs is shown by the facts of cerebral hemianæsthesia, but at the present time it appears doubtful where this crossing takes place. It is evident from the experiments which have been recorded, that monkeys vary both in the amount of sensory disturbance which follows hemisection and in the duration of the symptoms before restitution occurs; and the recorded cases in man of lesion in the upper cervical region show some irregularity in the distribution of the sensory defects in the arms. The facts of the experiments in the upper cervical region show that all forms of sensibility were not abolished on the non-paralysed arm; sensibility to painful impressions was absent or defective, except in the third experiment, while the sense of contact was retained. On the paralysed arm, with retention of the sense of pain, evidence of tactile sensibility was obtained within a short period of the operation. This would appear to indicate that the fibres subserving tactile sensibility for the arms pass up both sides of the cervical cord, while those subserving painful and temperature sensibilities mainly pass up the opposite side. On the other hand, the experiments indicate that all forms of sensibility, with the exception of a sense of pressure in some monkeys, notably in experiment 4, are abolished in the lower limbs, temporarily at least, on the side opposite the lesion. In this connection we will here refer to the existence of a sense of pressure, more or less accurately localised, as shown by the clamp test. When the clamp was applied to the skin of the foot on the non-paralysed or anæsthetic side, the leg was at once drawn up and the clamp removed, while the monkey never exhibited any signs of discomfort. When, on the other hand, the clamp was applied to the paralysed foot, the animal at once began to struggle and bite, and show signs of annoyance, which continued during the time the clamp remained on, but it never tried to remove it. If, however, the anæsthetic limb was held, the animal never attempted to remove the clamp until the limb was set free and its movements unrestrained. In the fifth experiment, as long as the limb remained anæsthetic to all other forms

of stimulation, no attempt was ever made to remove the clamp forceps.

There is, perhaps, greater difficulty in determining the condition of the muscular sense in animals, the conclusions depending entirely on the interpretation of the observed facts. The following observations appear to indicate that there is loss of the sense of movement in the lower limb opposite the lesion. When the animal was lying on its back, it could freely move and kick with the anæsthetic limb, but this leg was never used for prehension, as, for instance, when it was climbing the lattice-work of the cage. If a finger or other object was inserted between the hallux and the toes, no attempt was made to grasp it. If, when the eyes were blindfolded, the leg was moved about, the monkey never offered any resistance. If by chance the leg was caught upon an obstacle lying upon the floor, it was quite incapable of extricating it. All this, however, changed when the cutaneous sensibility returned.

The Restitution of Function.

1. *The motor functions.*—The collected cases and the experiments detailed above show that the functions of the side of the spinal cord which has been injured are in course of time restored. It has been pointed out that the movements returned in the paralysed limbs at different periods after the operation. The first movement to return is flexion at the hip-joint, and this occurred from a fortnight to three weeks after the infliction of the injury. Closely associated with this is the counter-movement of extension, and a short time later movements at the knee-joints are regained. Drop-foot remains for a very long time, apparently, after some of the movements of the hallux and toes have returned. Return of the functions of the paralysed arm occur much later than in the paralysed leg. First, movement at the shoulder joint, followed a little later by flexion and extension at the elbow ; in the third experiment, drop-wrist and inability to move the thumb and fingers persisted one hundred and twenty days after the operation. It therefore comes to be a very important point to ascertain

how this restoration takes place. Regeneration of the white fibres of the spinal cord probably does not occur, at any rate, in the higher mammals, although definite evidence on this point is not yet forthcoming. Eichhorst (*Virchow's Archiv.*, 1874, p. 1) found new nerve elements in the scar tissue resulting from section of the spinal cord in young dogs and rabbits. Our own observations do not confirm this, for the cicatricial tissue which filled in the gap made by the knife at the time of the operation in no case presented any evidence of regenerating nerve fibres. As no regeneration took place at the seat of the lesion in the experiments under discussion, the impressions were probably conveyed to the parts below the lesion by the opening up of decussating paths from the opposite uninjured side. Experiments seem to corroborate this view. The first experiment demonstrated that after the recovery of movement from a section of one side of the cord, section of the opposite side a little higher up caused permanent paralysis of both lower limbs. And two experiments performed by Rossolymo (*Neurol. Centralbl.*, 1887, p. 292) on guinea-pigs, entirely confirm this. In one experiment he performed a hemisection of the spinal cord at the tenth dorsal nerve root; and when the paralysis of the hind limb resulting from this had passed off, he made *on the same side* another section just behind the decussation of the pyramids. This occasioned paralysis of the fore limb on the same side, while the hind limb escaped. In a second experiment, after restoration of the movement resulting from a hemisection in the lower dorsal region, he made a vertical longitudinal incision throughout the lumbar enlargement, with the result that the leg was a second time paralysed. He had previously shown that such an incision produced no paralytic effect on either limb. Dr. Mott's experiments (*Proc. of Physiol. Soc. in Journal of Physiology*, Jan., 1891) on stimulating the motor cortex after recovery from the paralysis of a hemisection confirm this, for he found that excitation of the cortical area of the opposite leg evoked movements in both legs.

2. *Sensory functions.*—The restoration of these functions is a subject which has not as yet received very much atten-

tion. In cases of "Brown-Séquard's paralysis" which have been observed several months or years after the onset of the symptoms, no very marked improvement is found to have occurred in the sensory conditions: in one example seen twenty one years after the fall which caused the paralysis, all forms of sensation were abolished with the exception of touch, which was very defective. An analysis of the order and date of return of the sensibilities in the monkeys, which have been the subjects of our experiments, shows a condition differing considerably from the recorded cases of disease or injury in Man. In three of the experiments evidence of the return of the perception of painful impressions was obtained by the fifth or seventh day after the operation. The perception of these impressions was at first very defective. An amount of pricking and heat which caused distinct manifestations of feeling on the paralysed limb, on the non-paralysed only provoked a sense of slight discomfort; the monkey scratched the place irritated, but never or rarely struggled. In the second and third experiments the perception of tactile impressions returned contemporaneously with that of pain. It appears that in the monkey at any rate, probably owing to the less highly organised state of its spinal cord restitution of the sensory functions occurs at a much earlier date after the infliction of an injury, than obtains in the highly organised cord of man.

The Paths of Sensation.

Brown-Séquard's view of the existence of special conductors for the diverse kinds of sensory impressions and of different paths for their conduction in the cord, was based on the facts of many of the cases previously alluded to, viz., that one kind of sensibility was preserved while another was lost. He concluded that the temperature sense was probably conducted by the central grey matter, painful impressions by the posterior and lateral parts of the grey matter, while the tactile sense was conducted by the anterior parts of the cord. More recent observers have suggested other paths for the conduction of sensory impressions. Schiff suggested that tactile sensibility probably passed by

the posterior columns, painful impressions being conveyed by the grey matter, while Dr. Gowers has advocated the antero-lateral ascending tract as a probable path of painful sensations. Experiments have been performed recently which do not corroborate these views.[1] Section of the outer portion of the lateral column in a monkey produced no effect upon sensibility below the lesion, while section of the whole of one side of the spinal cord, with the exception of the anterior and posterior median columns, gave rise to total anæsthesia and analgesia on the opposite side. The experiments tend to show that all forms of sensation pass up the cord in very close relation to each other, and their synchronous restoration after hemisection would favour this view. It has been suggested, because the ascending degenerations which follow hemisection are limited to the same side of the cord, that therefore the sensory fibres do not entirely decussate. It is true that anatomically the ascending degenerations are limited to the same side as the lesion, but clinically the anæsthesia is on the opposite side. The recent experimental work of Messrs. Gotch and Horsley[2] on the electro-motive conductivity of the spinal cord, favours the views of Longet and Schiff, that the posterior columns on the same side are the main afferent channels. Their method of research undoubtedly shows the existence of unbroken tracts of fibres passing up the cord on the same side as the entering posterior nerve roots, which the degenerative method also brings into prominence, but neither method distinguishes between centripetal impressions and sensation proper. Our experiments indicate that the tracts subserving sensation, until restitution occurs, pass up the opposite side of the spinal cord.

The reflexes.—The state of the reflexes, both superficial and deep, is of some clinical interest.

The experiments show that immediately after, and for a short time subsequently, the knee-jerk on the side of the lesion was in abeyance or very much diminished, while that

[1] Ferrier, "Croonian Lectures," 1890, p. 95.

[2] Gotch and Horsley, "Croonian Lectures," 1891. *Phil. Trans.*, vol. 182B., pp. 267-526.

in the opposite side remained normal. Within a short time (a few days in most cases) the hitherto absent knee-jerk returned, at first sluggishly, and then of normal strength. In the first experiment, where resection of the opposite side of the cord was performed, the knee-jerks showed similar variations, absent on the side of the lesion, of apparently normal amount on the opposite side. As rigidity and contracture proceeded, both knee-jerks became exaggerated; the superficial reflexes, especially that occasioned by tickling the sole of the foot, were in all cases found to be intensely exaggerated on the side opposite the lesion, those on the same side were either in abeyance or only slightly marked. The exaggeration of these reflexes remained for some weeks, when they gradually diminished to the normal extent. In the first experiment, where a second section was made on the opposite side, similar exaggerations occurred on the side opposite to the lesion; they showed no signs of diminution, while those on the other side increased as rigidity and contracture progressed.

Vaso-motor and trophic effects.—Immediately following the operation, the temperature on the paralysed side was found to be considerably higher than on the non-paralysed. This lasted for several days, but with the return of the motor functions, the elevation of the temperature subsided. In one experiment the temperature on both sides had become equal by the twenty-fifth day.

The muscles of the paralysed limb atrophy to a small extent, the circumference of the affected limb was less, and the muscles were soft and flabby. Their reaction to electricity was not materially altered. The limb remained slightly atrophied after the return of movement. Cutaneous tropho-neuroses were observed in only one case on the side opposite the lesion.

Organic functions.—In the recorded cases of wound of the spinal cord giving rise to the symptoms and signs of a half lesion, involuntary passage of urine and fæces was noted for some days. This was never noticed in any of our experiments, although retention of urine was usually present for twenty-four hours after the operation.

In none of the experiments was any impairment of the respiration observed, not even in the high hemisections immediately after the operation.

ADDENDUM.—The following is the condition of the monkey illustrating the fifth experiment on the *thirtieth day* after the operation:—There is perception and localisation of tactile and painful impressions on the left upper and lower extremities, and the left side of the trunk. On the right upper limb the sense of touch is well marked, but the sense of pain is defective. On the right lower limb tactile and painful impressions are localised above the knee, while below the knee anæsthesia of both forms remains. There is rigidity and contracture of the paralysed extremities, while there is very little evidence of return of movement even at the left hip joint.

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ON THREE CASES OF HYSTERIA IN MEN.

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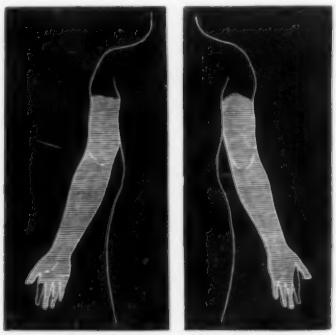
I WILL first of all give an account of the cases.

CASE I.—Stephen M., æt. thirty-three, a mattress maker. His family history was unimportant; his parents were healthy, but his mother was "nervous." No one in the family had ever had fits. At the age of ten months the patient had an attack of infantile paralysis, and since that time his right leg has been wasted; when seventeen years old he had inflammation of the lungs, and at twenty-nine an attack of "measles," during which he was for some days very ill. Twelve months ago he had an attack of "nervousness" and a troublesome cough. He is married and has one healthy child. Careful enquiry elicited no history of syphilis. He used to be a heavy drinker, but lately has taken less, though he is still probably intemperate, acknowledging to three or four pints of beer daily. He has never worked in lead.

During the last few months he has suffered from attacks of vertigo whilst walking; they last for ten minutes, occur about once in two or three days, and during them he has to stop and hold on to the railings or any convenient support. They begin with a feeling of numbness, starting from the feet and passing up through the body to the head, together with singing noises in the ears, severe pain in the forehead, and throbbing of the temples. There is no globus. His sight is not affected, he never falls, nor loses consciousness; only once "everything seemed to be going round," but on all other occasions this was not the case. He now complains of numbness in the fingers of the right hand.

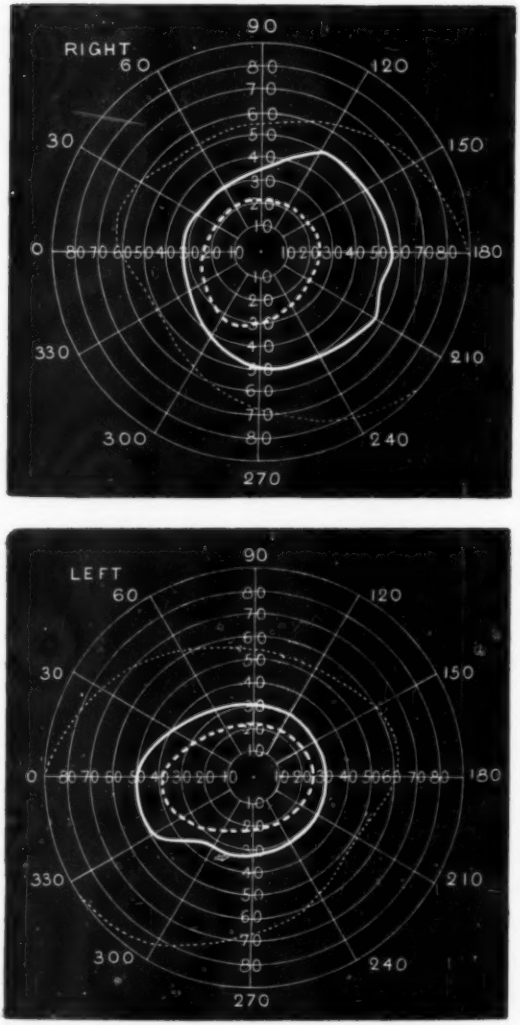
A week ago he had a pain in the left arm, and three days later, whilst at work cutting out the stuff of which the mattresses are made, his right hand and arm became numb, and he lost power in them: this numbness was unaccompanied by tingling or pain. Since then he has been unable to open his fingers, and has been obliged to give up his work. He is ambi-dextrous. In addition he suffers from attacks of morning sickness, from headaches, and his legs often feel very weak and powerless. He is giddy, especially in the dark, and has had a trembling of the hands for some time. There is no interference with micturition or defæcation.



Case I.

The shading indicates loss of sensation.

The patient was an anæmic man, fairly well-built. Examination of the thoracic and abdominal organs detected nothing abnormal. His pulse was regular, his tongue moist and thickly furred. The muscular system was well developed, except in the right lower extremity; in this the anterior muscles of the thigh were small and wasted, the right thigh measuring only sixteen inches in circumference, whilst the left measured twenty inches. The muscles of the leg showed a less degree of wasting, and the whole limb was a little shorter than the other. The right knee jerk was absent: sensation was unaffected. This condition of the right leg the patient stated had existed from



CASE I.

The inner thick dotted line indicates the field for red.
The outer thick white line indicates the field for white.

infancy, and was doubtless the result of the attack of infantile paralysis above mentioned. There was a very rapid, constant, fine tremor of the hands, which was not increased by movement, and from its characters might reasonably be attributed to alcohol.

The dynamometer gave 21 kilos for the right, 38 for the left hand.

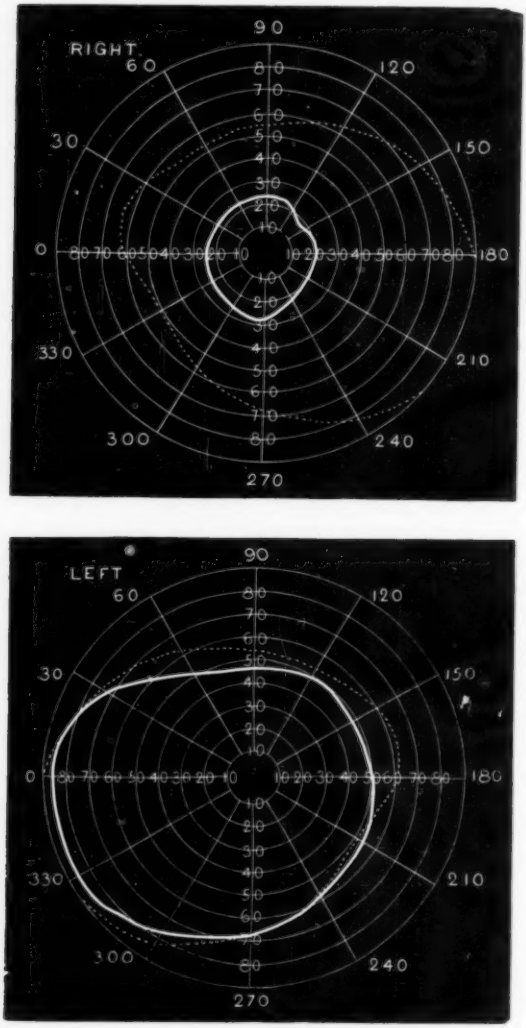
The right wrist and fingers were kept in a position of partial flexion, and there was a general loss of power, accompanied by some inco-ordination in all the movements of the right forearm, hand and fingers. No movements were entirely absent, and the paresis was most marked in the long extensors of the wrist and fingers, and in the action of abduction of the fingers from the middle line performed by the interossei. The other muscles, though weak, were affected in less degree, the movements of the thumb being least involved. The shoulder muscles acted normally. There was not the least evidence that the paresis could be attributed to lead. Sensation was almost lost to touch, pain, and temperature in the right upper extremity over the area shaded in the figure. Over the index finger, however, sensation was normal. The muscular sense was also completely lost in the fingers, and the patient could detect no difference between different weights; in the index finger this was not the case, and he could accurately distinguish between various coins by their weight; moreover the distance at which the points of the æsthesiometer could be detected as two was in this finger the same as over the fingers of the left hand. There was partial loss of muscular sense in the forearm. Elsewhere over the body sensation was entirely unaffected, and there were no tender spots. The sense of smell was normal; taste was very deficient on the right side of the tongue, pepper and quinine being indistinguishable. The bilateral contraction of the visual fields is indicated by the charts. The left knee jerk and superficial reflexes were normal. There was no paralysis of any cranial nerve. The pupils were equal, and reacted well to light and accommodation. It should have been mentioned above that the right forearm and hand were colder than the

left, and slightly livid, and that the electrical reactions of the muscles were normal.

Under general treatment with faradization and rubbing of the affected limb he gradually improved, and at the end of four weeks was able to return to work with fair power in the right hand, and with marked improvement of sensation. At the end of two months he considered himself well, though sensation was still a little less acute over the right than over the left hand, and he ceased to attend.

CASE II.—The second patient, Thos. S., æt. twenty-eight, came to me in December, 1890, complaining of "fits." He was a quarryman by occupation, and was a strong, healthy-looking man of about middle size. He was somewhat excitable in his manner of speaking; intelligence good. The family history was good: both parents were healthy, his father being a temperate man of mild disposition; he had ten brothers and sisters, all of whom were healthy. None of the family had ever suffered from convulsions or fits of any kind, nor from chorea, insanity, or asthma. He was a married man, and the father of five healthy children. He had always been a teetotaller, and had never had any bad illness. He was of a very religious disposition, and was fond of taking part in religious revival services. He had not been engaged in any excitement of this kind before the onset of the first fit, which came on without apparent cause, whilst at his usual work in a quarry during very cold weather four years ago. Since then he had had a great many attacks, for none of which he could trace a cause, except that either very hot or very cold weather always seemed to bring them on. They generally occurred in the evening or at night. Sometimes he would go for some months without an attack, and then would have a number of them in a short time.

He gave the following description of the fits:—There is first a throbbing in the temples, which lasts from three to five minutes, and as it passes off a feeling of "deadness," numbness, or loss of sensation comes on in the tips of the fingers, and passes up through the arms to the back of the head, in which he at once has a severe pain as if he had received a

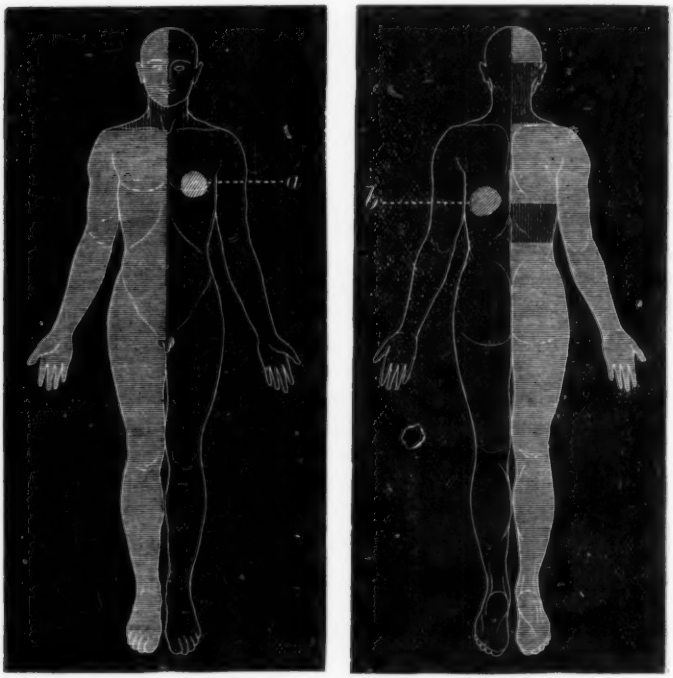


Case II.

The thick white line indicates the field for white.

violent blow there. This is followed by pains in the forehead; at the same time the numbness spreads from the shoulders all over the body, but seems especially to pass into the pit of the stomach and the left side of the chest. These symptoms last from a few seconds to a minute. He does not generally fall, because he sits down at once when he feels it coming on. During this part of the attack his feet are agitated, and beat against the floor. The numbness is succeeded by tingling, which he compares to the pricking produced by a faradic current (with which he had at one time been treated). This tingling begins in the fingers, and spreads all over the body as the numbness did, whilst the pains in the head become more severe. At the moment when the numbness dies away he feels faint, as if sinking through the earth. Sometimes there is loss of consciousness. More often there is not, but a condition in which he is unable to speak but hears everything that is said around him. Loss of consciousness appears to come on only when the pains in the head are of exceptional intensity. This faintness may last half an hour, or less. He has occasionally fallen in it, but has never sustained any greater injury than a trifling bruise from the fall. In the faintness he struggles "as if fighting against a battery," throws his arms and legs about and grinds his teeth. He does not scream, but moans and makes "gurgling" noises in his throat. He is always better if left alone, and if held his struggles become more violent. Occasionally, and especially when he is coming round from those attacks in which there has been brief loss of consciousness, he talks wildly, chiefly about religious matters or political questions, and then his prevailing idea is one of intense anxiety as to the state of his neighbours' souls. There are apparently no hallucinations, but when he opens his eyes at the end of the attack everything appears to be coloured, sometimes with all the colours of the rainbow, at others of a uniform red or blue tint. The attack ends with violent palpitation, which prevents sleep, although he feels intensely drowsy. There is no feeling of weakness or exhaustion after them. Palpitation never occurs except at the finish,

and throughout there is no globus nor are there noises in the ears. The fits rarely occur singly, but in series of three or four. The greatest number at a time was five, and the whole series then lasted three-quarters of an hour. He has never bitten his tongue nor passed water in any of them.



CASE II.

Transverse shading—Anæsthetic area.

Vertical shading—Areas unaffected, or only very slight loss of sensation.

a. Hysterogenic area.

Transverse shading—Anæsthesia and analgesia.

Vertical shading—A slighter degree of anæsthesia.

b. Area of hyperæsthesia.

Apart from the attacks he often suffers from severe pains in the back of the head, but otherwise enjoys good health. He sleeps well, and his appetite is good. He suffers from constipation.

Examination showed that there was no paralysis of any muscle; the muscles were generally well developed, firm, and of normal strength. The knee jerks were present, the plantar reflexes absent; other superficial and deep reflexes normal. Physical signs in thorax and abdomen normal. Pupils equal, react well, and are slightly dilated; optic discs and fundus healthy.

There was well-marked anæsthesia over the right side of the body, which was accurately limited by the middle line in front and behind. Anæsthesia was complete to pain, a prick not being felt, almost complete to touch and to temperature. This anæsthesia was less marked on the neck, especially on the back of it, and over an area on the right lower ribs posteriorly, which is indicated on the chart. The right conjunctiva was also normal in respect to sensation, but the left conjunctiva was anæsthetic. The right side of the tongue and buccal mucous membrane were also insensitive. At the lower angle of the left scapula was an area of hyperæsthesia, and another about the size of a five shilling piece just below the left nipple. Irritation of this latter area produced feelings of numbness and tingling, and on continuing the irritation he lay back on the sofa, with eyes turned up under nearly closed eyelids, the limbs became momentarily rigid, and were subsequently agitated by slight clonic spasms, and there appeared to be partial loss of consciousness, the whole attack lasting about a minute or so.

In addition to the other symptoms, loss of taste was detected on the right side of the tongue (quinine and constant current) and of smell in the right nostril (asafœtida, creosote, and ammonia); there was well-marked contraction of the right visual field. Under treatment he improved, and the fits ceased, but as he was only six weeks under observation, it could not be said with certainty that the improvement was permanent. He told us that attempts at hypnotism had formerly been made upon him, but always unsuccessfully.

Case III.—John J., æt. forty-two, a cabman, complained of pain, stiffness and contraction in the left arm and elbow. On enquiry there was a history of gout in the family, an uncle having died of it; his father died of a malignant tu-

mour of the neck, and his mother of inflammation of the bowels. He is an only child. No relative, so far as he knew, had ever been insane or suffered from fits.

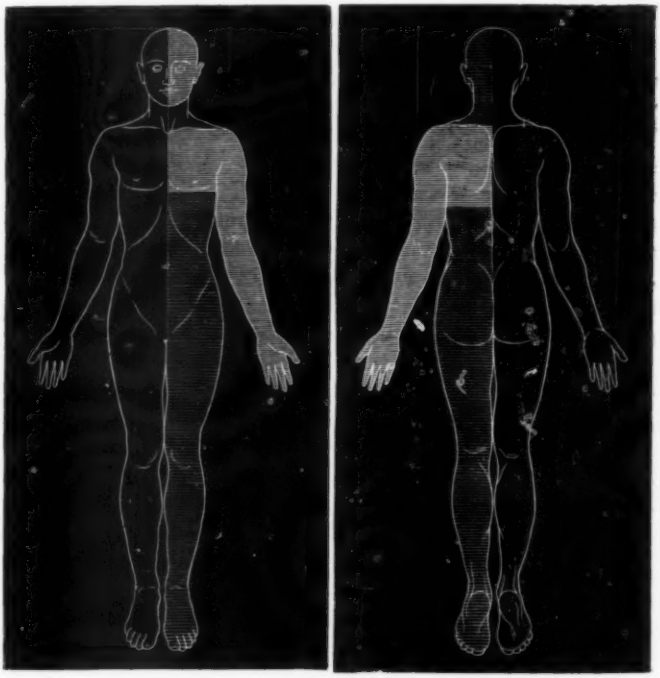
He had himself always been healthy, had never had rheumatic fever nor gout, nor convulsions of any kind. There was no history of syphilis; he had not been a very heavy drinker, although not strictly temperate in his habits.

The present illness began twelve months ago, with pain in the left arm, which came on during one night; the pain gradually grew worse, and four or five months ago passed down to the elbow, shooting from the elbow over the back of the forearm and hand into the tips of the fingers. The pains seem to start from a tender spot just above the internal condyle of the humerus, on the posterior aspect of the arm, and to shoot thence into the hand and shoulder. Nearly four months ago he was thrown out of a trap, and fell on his head, not striking his arm at all; he was rather shaken by the fall, and remained in hospital for two weeks, at the end of which time he was discharged, apparently well. Three months ago, or shortly after leaving the hospital, he found the elbow becoming stiff, and that movements were attended with pain in it; this condition of painful stiffness has gradually increased until at present he is unable to bend it at all.

As to general symptoms, his appetite is poor, he is very sleepy in the daytime, and is thirsty, drinking a great deal of cold water. His bowels are regular. When in the hospital after the accident he suffered for a short time from inability to pass water; this soon passed away, but since that time he has had to get up two or three times at night to micturate. Examination of the urine showed that it contained a deposit of urates, but no sugar nor albumen. His tongue was dry and thickly furred; he had, however, no dyspeptic symptoms. The heart, lungs and abdominal organs were normal, and his pulse regular and strong:—68 to the minute. His face was flushed, but otherwise he looked healthy.

The left arm was kept flexed at the elbow, so that the forearm was at right angles to the arm and supinated. This position of the forearm was due to a state of rigid spasm in the biceps. By continued pressure the spasm could be over-

come and the arm nearly but not quite straightened, and during this forcible extension the patient complained of much pain in the elbow. He was entirely unable to extend the forearm himself. The elbow-joint itself was perfectly healthy. There was a tender spot behind and above the



CASE III.

Over the area marked by the widely separated lines sensation was deficient, as compared with the right side.

Over the more deeply shaded parts there was more decided anæsthesia.

internal condyle, and also in front of the elbow on the outer side. There was no paralysis of any muscles, which were generally well developed, firm, resistant and not flabby. Electrical reactions normal. The knee jerks were both present, the left a little more active than the right, and

the superficial reflexes were normal. The contraction of the left arm placed it exactly in the position in which he was accustomed to maintain it in holding the reins in driving.

There was decided loss of sensation over the left upper extremity, over the shaded area in the figure; this was most marked, though nowhere quite complete, to touch; loss of sensation to pain was less complete, and the temperature-sense and that of position were not affected. There was similar loss of sensation to touch and to pain over the left half of the face, the left conjunctiva and the corresponding side of the tongue and mouth. Over the rest of the body and limbs there was on the left side, limited by the middle line, a partial degree of anæsthesia less marked than in the left side of the face and upper extremity. Taste (quinine and constant current) was lost on the left side of the tongue, hearing and smell were very deficient in the left ear and nostril respectively, and there was considerable contraction of the visual field on the same side. The fundus and optic discs were normal, the pupils equal, reacting well to light and accommodation. The left arm was extended as far as possible and placed in a splint for the first day or two. He then attended for electrical treatment, and the arm was well rubbed with a stimulating treatment Tonics were given internally, and in a short time he recovered completely.

The clinical features of these cases leave no room for doubt that the patients were suffering from hysterical affections. In the first case the nature of the paralysis of the arm and hand, if considered apart from the other symptoms present, might have been doubtful, but its appearance was preceded for some time by slight attacks of vertigo, the description of which seemed to correspond with that of the milder kind of hysterical seizure, whilst no organic lesion of the peripheral nerves, brain or cord could explain the peculiar distribution of the anæsthesia, limited above, as it was, by a straight line encircling the arm, and leaving the index finger entirely exempt; all forms of sensation being affected. In the second case the diagnosis was equally clear. The fits were those of the severer form

met with in hysteria, and in addition to hemianæsthesia there was a well-marked hysterogenic zone, irritation of which produced an attack, slighter indeed, but presenting essentially the same features as those for which he sought advice. I had not previously come across so well marked an instance of the hysterogenic zone.

Common to all three cases was the unilateral affection of the organs of special sense on the same side as the anæsthetic areas, and in two of them there was hemi-anæsthesia. As other observers have pointed out, although the patients themselves sometimes complain of numbness and loss of feeling over one side of the body they do not always do so; the affections of sensation and of the special senses require to be looked for, and when found give valuable aid in diagnosis, for if ordinary precaution is taken in the investigation they furnish physical signs of the neurosis which are not likely to be vitiated by incorrect statements, as the patient is unaware of their import.

In the first two cases no history of any physical injury or severe mental shock could be obtained after careful inquiry, and they must therefore be regarded as instances of hysteria occurring apart from the action of any traumatic or other of the usual exciting causes. But when we search for the predisposing conditions, we find in the first patient the results of an infantile paralysis, which may be taken as indicating a neuropathic taint in his constitution; he was a drinker, and there was evidence of a lowered state of his general health in the tremor of the limbs, possibly of alcoholic origin, while he was moreover decidedly anæmic. The second man was of an excitable temperament, much given to indulge in highly emotional forms of religious excitement, so that in both these patients we may fairly conclude that they were in a condition of health which rendered them suitable subjects for the development of a neurosis. In the second patient this took the form of hysterical seizures and hemianæsthesia without any local paralytic or spasmodic affection.

In Case III. we have the more usual history of an injury as the exciting cause of an hysterical contracture, for this distinctly developed after the fall from his cab. But from

the account which he gave us his health had been failing during the preceding twelve months, and he had been intemperate, so that in his case also the fall seemed to have merely brought into full action the already established tendencies to the neurosis.

Two of the cases have a feature in common, namely that the nature of their employment may have induced excessive fatigue in the limb affected, in the one case with paralysis, in the other with spasm. In each patient the limb most used in his work was the one affected, and in the cabman the arm was fixed by spasm exactly in the position in which he held the reins in driving The muscles involved were consequently those on which the greatest strain fell, which would continually be called upon to sustain greater efforts than the other muscles of the body, and the fatigue thus especially engendered in them may be supposed to have determined—in the general weakened state of the patients—the situation of the local affection. Why this should take in the one case the form of paralysis, and in the other, of spasm, it is difficult to see, but the explanation may lie in the different way in which the limbs were respectively employed, the mattress-maker in the operation of cutting out, constantly bringing into action the small muscles of the hand and forearm, which are easily tired, whilst the cabman maintained his arm for the greater part of the time in one position. The sense of fatigue arising from the constant fine movements suggesting in the former inability to continue the movement or paralysis of it, and in the latter the fixed position of the limb causing, at first cramp, and then a sense of inability to move the limb out of its strained position. It seems to me that, allowing for the influence of the shock of the fall in the last patient, that in all three cases the one common and important factor is an impaired nutrition of the cortical sensory and motor centres arising from a perversion of the general health. And that this impaired nutrition was an acquired condition, and not due to an hereditarily feeble nervous organisation seems to be clearly shown in two of the patients by the good family history which each of them gave; in the other the former occurrence of infantile paralysis and the statement that his mother was

nervous render this doubtful. One may add that the mental state of these patients in no way resembled that which is perhaps still too commonly held to be characteristic of hysteria.

I have brought forward these cases as they are good instances of hysteria in working men, in whom the frequency of the occurrence of hysteria was not recognized till recent years. That it does occur fairly frequently in men of the working classes in all countries is now no longer doubtful. At the same time it is not so very common to find it fully developed in this country, even amongst a large number of hospital out-patients. If we may judge from the cases published in the journals, instances of hysteria in men are relatively more seldom met with in country districts and in the upper classes. Most probably this arises from the conditions under which a large majority of the poorer classes in our large towns live. The severity of the competition in the struggle for existence is greater than in the country; they live under bad hygienic conditions from absence of pure air and sunlight, and from overcrowding in their homes owing to high rentals, and, in comparison with the upper classes, are harrassed by many pressing anxieties from which the well-to-do are exempt. All such conditions are well adapted to produce that debilitated state of the nervous system on which the neuroses are grafted.

With regard to the question of the relative frequency of hysteria in men and women, it appears to me that although the number of cases of all kinds is very much greater in the latter, if we divide, for clinical purposes, cases of hysteria into two groups—the first comprising those patients in whom hemianæsthesia, with corresponding unilateral affection of the special senses is present as a more or less permanent feature with the addition of hysterical seizures, muscular spasms and paralyses, and the second group those milder cases in which paralysis, spasm, or any slight seizures exist without sensory affection—then we shall find that the proportion of the first group to the second will be relatively greater in men than in women, although the total number of cases is much less. In other words, when hysteria does appear in men it is more apt to assume a severe form.

Critical Digest.

ON HYPNOTISM.

BY C. LLOYD TUCKEY, M.D.

If the importance of a subject is to be measured by the amount of literature devoted to it we must conclude that the present revival of hypnotism is destined to mark an epoch in medical history, for to the number of books and articles in reference to it there seems to be no end.

The student will perhaps be relieved to learn that there is little that is new or original in the later works, and that the ideas and arguments permeating them are very similar in their tone, whether they emanate from German, French, American or English sources. The subject-matter is found to fall under the heads of theory, experiment and clinical experience, and the doctrines set forth show a leaning towards the teaching of one of two schools—that of Paris or that of Nancy.

Those writers who draw their inspiration from Professor Charcot agree in regarding hypnotism as an induced neurosis closely allied to hysteria, and therefore pathological; while those who range themselves on the side of Professor Bernheim refuse to see in hypnotism anything but a physiological condition almost identical in its nature to natural sleep. Charcot considers hypnosis a distinct entity marked by the presence of certain somatic phenomena; while Bernheim denies that there are any but psychical phenomena characteristic of the condition, and refers everything occurring during it to suggestion.

It is satisfactory to see that the fierce controversy which has been waged between the partisans of the two schools for the last seven or eight years shows signs of abatement, and it will probably ere long be terminated by mutual concessions on both sides.

As it is quite impossible to give in the limits of a short article a lucid account of all the recent books on hypnotism, it is proposed to apply ourselves in the following pages more especially to the consideration of two or three representative books which have recently appeared from the pens of two distinguished French writers.

Professor Bernheim's latest work[1] follows somewhat similar lines as his previous book,[2] and is in fact, as he says, a continuation of it. It is divided into two parts, in the first of which he devotes himself to the consideration of the theory of hypnotism and the *rationale* of cures of psychical origin generally, and in the second he deals with the practical application of his theories as demonstrated by the detailed report of over a hundred clinical cases.

Professor Pitres'[3] book is in two volumes. The first is given up to the discussion of hysteria, and is one of the most important works which has appeared on the subject within recent years; and the second is chiefly occupied with hypnotism and its phenomena. It is with the latter volume that we are at present concerned. Its title, and the fact that the preface is written by Professor Charcot, afford evidence of Dr. Pitres' mental bias.

Bernheim defines hypnotism as "The production of a psychical state in which the readiness of the mind to receive, and its ability to carry out, suggestion are greatly increased;" p. 15[2] and suggestion as "The act by which an idea is introduced into the brain and accepted by it as true," p. 24[1].

It may be observed that these definitions are very extended in their application, and that they do not mention drowsiness or sleep as necessary factors. Dr. Babinski[4] objects to them because they can be made to include many mental states in which, to his mind, there is no question of hypnotic influence; and this at once brings us to the point that much of the difference of opinion between the schools

[1] *Hypnotisme, Suggestion, Psycho-Therapie*, Etudes Nouvelles, Paris, 1891, 1 vol. 8vo, p. 518.
[2] *Suggestive Therapeutics*, translated by Dr. J. A. Herter, Edinburgh and London, 1890, 1 vol. Oct. p. 420.
[3] *Leçons Cliniques sur l'Hystérie, et l'Hypnotisme*, Paris, 1891, 2 vols, 8vo.
[4] *Hypnotisme et Hystérie*, 8vo, Paris, 1891, p. 43.

of Paris and Nancy depends upon failure on the part of their respective adherents to understand the position of their opponents.

Bernheim purposely leaves the definitions vague and comprehensive, because he wishes them to embrace a large number of instances in which the objective signs of hypnosis are entirely wanting. His contention is that hypnotism merely acts as the psychical preparation or vehicle for suggestion; and he only induces it because he finds that in the hypnotic state the subject's mind can be concentrated on the idea of cure, and can be made to exert an influence over functions which, under ordinary circumstances, are beyond the control of the will. That the production of drowsiness is not necessary to cure of psychical origin is, he thinks, proved by the number of authenticated instances in which functional diseases have been removed by pilgrimages to shrines, and by faith healing, and he endeavours to propound a comprehensive theory which will cover all these cases.

When an idea is received by the subject as true, it tends, says Bernheim, to be realised in action, p. 31[1]. The thought of cold makes one shiver, and the remembrance of a disagreeable taste or smell produces a feeling of nausea; the idea of dancing occasions a rhythmical movement of the feet, and the idea of pain evokes a feeling of local uneasiness. The vividness of the mental image and the extent of its corresponding accompaniment, whether motor or sensory, depend on the subject's receptivity and the strength of his imagination. Hypnotism increases mental receptivity and heightens the effects of ideo-motivity. The person in a normal state, if told that it is cold, will compare his present sensations with his previous experiences, and will accept or reject the propostion as his judgment dictates, but if profoundly hypnotised he will receive the statement as true, and will at once exhibit all the subjective signs of chill. If he be very receptive and sensitive, and the suggestions are forcibly repeated, he may even develop the *cutis anserina*, and other objective signs of extreme cold.

Neither Bernheim nor Pitres in the two books especially before us enter much on the discussion of the physiological basis of hypnotism and suggestion, but Professor Tarchanoff[5] has recently contributed a very clear and satisfactory monograph on the subject, and as the theory he propounds is that now generally held it may find proper mention here. Tarchanoff has continued the researches of Heidenhain[6] on the connection between hypnotism and cortical inhibition, and has come to similar conclusions on the subject. Briefly stated his theory is this. Under ordinary circumstances attention is being given and nervous energy is being expended in many directions in consequence of the arrival at the highest centres of impressions derived from all the avenues of sense, and a distribution and equilibrium of nervous action result. The person who is hypnotised by the method of fixation has his whole attention directed on a single sensory impression derived from one sense—the image of a brilliant object held before the eyes. This one-sided and excessive stimulation of one centre leads to the gradual inhibition of the cortical areas of the other senses, for it is impossible for more than one centre to be in excessive activity at the same time. As the subject's attention becomes more and more concentrated on the object he becomes less and less occupied with the life of relation until at length he is conscious of nothing but the visual impression. Over-stimulation of the visual centres leads to their exhaustion and consequent cessation of function, and a state of blank unconsciousness and senselessness ensues in consequence of impressions no longer reaching the cortical centres. The resulting condition is compared by Tarchanoff to what happens when all light is excluded from a room. If into this darkened chamber a ray of light is thrown it will shine with exaggerated force and brilliancy owing to the absence of other rays; and an idea suggested to the mind of a hypnotised subject will in a similar way assume abnormal weight and importance from the absence

[5] *Hypnotisme, Suggestion, et Lecture des Pensées* (French translation), Paris, 1891.

[6] *Animal Magnetism* (English translation), London, 1888.

of contending or controlling ideas. It will become an impulse and tend to be realised with almost irresistible force.

The state of mental vacuity in which the subject lies is well shown by one of Pitres' experiments, which also demonstrates how some persons respond to other than verbal suggestions. He hypnotised a young woman named Albertine, and she at once passed into a condition of profound trance in which she lay motionless and expressionless. On asking what she was thinking of she replied "Nothing," and her face showed no sign of intelligence. She was then placed in a kneeling posture with her hands clasped, and immediately her face, previously so dull and apathetic, lighted up and assumed an aspect of devotion resembling that seen in religious ecstacy, while her lips were seen to move. "What are you doing?" questioned Dr. Pitres. "Saying my prayers," answered the girl. When asked what she saw she replied "The Virgin," and proceeded to described her dress and appearance. In this case the attitude suggested the idea, and the thought provoked the hallucination, p. 155[5].

It is not difficult to understand how a suggestion thus become a dominant idea will affect the subject's conduct, at least for a time, and until it has been corrected or displaced by other impressions, but it is not so easy to explain the action of suggestion on organic processes and functions which are ordinarily beyond the influence of psychical agencies. It has, however, been abundantly shown by the researches of Beaunis,[7] Preyer,[8] Tamburini,[9] Krafft-Ebing,[10] and many other investigators, that hypnotic suggestion can be made to profoundly affect these. They have provoked local hæmorrhages in the form of stigmata from the skin, and discharges of blood from mucous surfaces. They have produced blisters from postage stamps by suggestion, and have rendered real blistering fluid inert by the same means. These results can of course be only rarely seen, as subjects of such susceptibility are not often met with, but Bernheim

[7] *Du Somnambulisme Provoqué*, Paris, 1886.
[8] *Der Hypnotismus*, Vienna, 1890.
[9] *Riv. Speriment. di Frenatria*, vol. xvi.
[10] *Eine Experimentelle Studie*, &c., Stuttgart, 1889.

contends that if deep-seated and intense action is possible in exceptional instances, a sufficiently powerful, though less profound, effect is obtainable in many cases, and that hypnotic suggestion may thus be made to exert a curative influence in disease. He maintains that though he cannot evoke local hæmorrhage or blisters in an ordinary subject, he is able to exert such an influence over the vaso-motor and trophic centres that he can modify the blood supply and affect nutrition to a considerable extent. He therefore employs hypnotism not only in hysterical neuroses but in general constitutional and organic diseases; and it is on this point that we find the greatest difference of opinion between Paris and Nancy. Charcot and his pupils admit that it is legitimate to induce a state they regard a pathological in certain obstinate forms of hysteria, and grant that the effect in these cases is often palliative and sometimes curative, but they refuse to consider the treatment applicable except to a very limited extent, and look upon it as a dangerous and uncertain remedy at the best. As for the employment of the minor grades of hypnosis—*le petit hypnotisme,* as they term it—they seem to regard it as entirely ineffectual and unscientific. And yet the great majority of people are only susceptible to the minor hypnotism, and the physicians who have taken up the question declare that they often cure their patients when the only symptom of hypnotic influence is a slight degree of drowsiness or torpor. Pitres quotes from the writings of Wetterstrand, Van Eeden, and Van Renterghem, De Jong, Schrenk-Notzing, and Tuckey, besides those of Bernheim and other French physicians, and expresses surprise and doubt at the statistics they have published, and gives his own experience in a number of cases in which he has tried hypnotic treatment. This experience seems to have been most unfortunate, for in the majority of cases where he did no harm he failed to do good, and in the few instances where apparent benefit followed it turned out to be only temporary or delusive.

Bernheim's statistics tend to show that if we are to accept Charcot's dictum that only hysterical persons are

hypnotisable, and that the hypnotic state is practically a form of hysterical invasion, we must modify and greatly enlarge our conception of hysteria, for he finds that he is able to influence at least 90 per cent. of his hospital patients, and that about half of this number are affected to the extent of profound sleep or somnambulism. It is his experience, and also that of all the writers who adopt his views, that soldiers, sailors, agricultural labourers, and mechanics are the best subjects for hypnotism and the most amenable to hypnotic suggestion. Is it possible, he asks, that these persons are all hysterical or even neurotic? Are they not rather the classes who, from their occupations and family histories, form the least neurotic element of the community? Moreover nearly all children are hypnotisable, and hysteria is uncommon before the age of puberty. Many strong, robust and phlegmatic men fall at once into a state of complete unconsciousness with amnesia on waking and susceptibility to post-hypnotic suggestions, thus affording examples of the profoundest somnambulism, and yet they are not found to exhibit the somatic phenomena described by Charcot as characteristic of profound hypnosis. He therefore considers these cases as abortive, incomplete, and *fruste* forms of hypnotism.

Looking at the matter with an unprejudiced eye, it seems certain that Charcot's three stages are very rarely of spontaneous occurrence, though we need not accept Bernheim's view that they never occur except as the result of suggestion. Pitres was unable to show the students attending his lectures on hypnotism a single typical case, as he said there was not one in the hospital, but he affirms that he has seen several cases of spontaneous occurrence, and Tamburini, Lombroso and other Italian investigators assert that they have met with instances in which the possibility of suggestion was most carefully eliminated. The condition is therefore confessedly extremely rare, and is probably, as Tamburini says, an exaggeration produced by hypnotism of the increased reflex excitability characteristic of hysteria. Vizioli has recorded a case of *grande hystérie* in which Charcot's phenomena were elicited without hypnotism,

p. 128[2], and both Bernheim and Pitres quote cases where it was impossible to say which symptoms were due to hypnotism and which to hysteria. The fact that it is impossible to hypnotise a person during an access of hysteria is adduced by Babinski as corroborative of his assertion that the two conditions are identical, but it does not necessarily follow, for it is also impossible to hypnotise a person in the epileptic condition or in a state of intoxication. On the other hand Bernheim has frequently succeeded in influencing patients in hysterical paroxysms by suggestion and in guiding their fancies and movements, p. 175[1].

Bernheim does not consider that hysterical persons are the best subjects for hypnotism or the most satisfactory patients for suggestive treatment. Morbid auto-suggestion is, he finds, extremely apt in the first place to interfere with the acceptance of the suggestion, and in the second place to lead to a relapse. According to his definition a suggestion does not act unless it is accepted as true, and it is notorious that hysterical persons are often extremely unwilling to receive assurances of cure, and that if they receive a suggestion for a moment they often reject it on waking. Professor Forel states that in employing hypnotism our object is to bring the action of a healthy mind to bear on bodily disorder, and if the mind itself is diseased—as it so often is in hysteria—the very groundwork of success is wanting. The cures therefore effected in hysterical subjects are apt, as Pitres contends and Bernheim admits, to be of temporary duration. Unfortunately this is the case with all methods of treatment in such subjects, and it is not therefore surprising to learn that we have not found in hypnotism an infallible remedy for hysteria.

Nevertheless Bernheim, Dumontpallier, Déjerine, Babinski and other well-known hospital physicians report brilliant cures of hysterical neuroses, *e.g.*, megrim, pseudo-paraplegia, contractures, anæsthesia by hypnotic suggestion, and testify that the results have sometimes been lasting. Both Bernheim and Pitres point out that "suggestibility" is a variable quality, and that whereas some persons are open to suggestion without hypnotism, others refuse to entertain sug-

gestions even when in a state of profound somnambulism. Bernheim, for example, quotes the case of a female patient who was under his care in the hospital for phthisis pulmonalis. He had not hypnotised her when one morning he stopped at her bedside and told her how she and the other patients had been disturbed the previous night by the misconduct of her neighbour, who had danced about the ward and made such a turmoil that it had become necessary to call the resident superintendent, who had come down in his dressing-gown and had with some difficulty induced the riotous patient to go back to bed. On making his rounds a few hours later he asked the woman how she had slept the previous night, and she at once replied that she and the other patients had been kept awake by the misconduct of her neighbour, who had made a great disturbance and had required the presence of the superintendent to quiet her. She then described the circumstances very much more fully than he had, and expressed herself as quite positive of the truth of her statements. Bernheim infers that from the facility with which he is often able to make persons, especially patients suffering from lingering diseases, believe absolutely groundless stories by simply repeating them in their hearing, that a very large amount of false evidence is manufactured by suggestions in this way, p. 175[2]. On the other hand, Pitres mentions how one of his patients, a woman, who was amnesic on waking and anæsthetic during hypnosis would yet refuse to perform any action to which she objected, p. 165[3], or to receive the suggestion of any hallucination or delusion.

Bernheim contends that hypnotism enables the physician to relieve symptoms and reduce them to their anatomical expression even in cases of incurable organic disease, and in replying to Dr. Gilles de la Tourette, who had twitted him with treating phthisis pulmonalis by hypnotism, and asked him whether he hoped to destroy the bacillus by suggestion, said—"I sometimes hypnotise patients suffering from tuberculosis not in order to suggest the disappearance of the tubercle, but to suggest that the patient shall sleep well at night instead of lying awake; and I find suggestions often

succeed in restoring his appetite as well as in calming his cough, easing his pains, and improving his spirits. In doing this, it seems to me, that I fulfil the indications of the case, and if I do not cure him, I at least relieve his suffering. Sometimes, indeed, by modifying the conditions I increase his vital powers, enable him to resist the action of the microbes, and thus retard, if I do not cure, the disease," p. 209[1].

Bernheim points out that in many diseases of the brain and spinal cord, the symptoms have their origin not only in the area affected by gross lesion, but depend also on sympathetic derangement of neighbouring structures; and Pitres shows how the hemianæsthesia which sometimes occurs in cases of lesion of the posterior third of the internal capsule, does not depend upon section of the nervous fibres of the capsular region, but on simple functional derangement of adjacent ganglia, and in many respects resembles hysterical hemianæsthesia.

Babinski, in criticising the details of one of Bernheim's cases, also shows that the greater number of the symptoms accompanying a case of advanced cerebral disease may depend upon sympathetic disturbance, p. 41[4]. The case was one of left hemiplegia, with hemianæsthesia dating from an attack of coma a year before. The patient had post-hemiplegic lateral tremor simulating insular sclerosis, contracture of the left arm and leg, and exaggerated reflexes. He suffered much from dyspnœa dependent on emphysema. Hypnotic suggestion caused the rapid cessation of the tremor, relaxation of the contracture, return of common and painful sensation to the left side, return of the power to stand and walk. In time he became able to walk without a stick and with very little dragging of the limb. The improvement in the dyspnœa was very marked. The amelioration of all the symptoms continued for two years, during which time the man was kept in the hospital and occasionally hypnotised. The emphysema, however, gradually developed, cyanosis set in, and the patient died from pulmonary congestion and cardiac failure. The autopsy revealed foci of yellow softening in both hemispheres, upon the convexity of the left occipital

lobe, and in the right hemisphere immediately behind the posterior extremity of the optic thalamus. Almost all the posterior portion of the external segment of the corpus striatum was destroyed, and its place occupied by a cavity filled with fluid. The medulla, pons medulla, and cord were not implicated, nor was there any degeneration of the pyramidal tract. Bernheim, in commenting on this case, suggests the possibility of suggestion having re-established the conductivity of sensory impressions by other tracts in place of those destroyed, p. 225[2]; but Babinski considers that hypnotic suggestion simply affected the hysterical element of the case. Whatever may be the correct explanation, the fact remains that a man suffering from grave organic disease of the brain was very greatly benefited by suggestion and enabled to walk long distances and feed himself for two years, after having been unable to for more than a year.

Several cases have been reported in English and foreign medical journals where the symptoms of locomotor ataxy have been greatly modified by suggestion, especially in respect to pain and co-ordination of movement; and Bernheim attributes the success of treatment by suspension to suggestion and the action of psychical causes. He has made a number of experiments, and has found that his patients were equally relieved whether the tension was real or only apparent, p. 61[1].

To explain the action of hypnotic suggestion on functions which are ordinarily beyond the influence of the mind, Bernheim evokes the theory developed by Dr. Hughlings Jackson and other physiologists, that the highest cortical centres not only subserve consciousness, volition and other faculties of higher cerebration, but also exert a controlling influence over the functions of the vegetative system. This influence, however, is not exercised under ordinary circumstances, but it is sometimes called into action in emotional states, and can be evoked by suggestion during hypnosis. Professor Delbœuf of Liége, imagines that the mind being withdrawn from the life of relation with which it is normally occupied, can be made to exercise during hypnosis a controlling influence over functions with which

in the waking state it does not concern itself, and Liébeault, the venerable pioneer of hypnotic suggestion, supposes that in the hypnotic state we can direct nerve energy which is being discharged in wrong directions into the channels most beneficial to the organism. According to Bernheim every part of the organism is represented in the brain, and every gland and muscular bundle is ultimately innervated by a motor or other cell in the cerebral cortex, which is its *primum movens*. It is by influencing those cells that we are able through hypnotism to affect trophic function.

Whatever may be the true explanation of its *rationale* there seems no doubt but that in hypnotism we possess a remedial agent of great power and considerable usefulness. While admitting its power for good, some persons who have given attention to the matter have come to the conclusion that the risks attending the popularisation of hypnotism outweigh the good effects which are likely to follow its widespread employment, and their position is worthy of consideration.

If hypnotism is permissible at all, it is clear that it should be kept as much as possible in the hands of experienced medical men, and be used by them with caution and judgment. Its employment by ignorant or unscrupulous persons is certain to lead to similar abuses as brought mesmerism into disrepute.

It is refreshing to find that the schools of Paris and Nancy, while differing upon nearly every other point, agree about the necessity of regulating the use of hypnotism. In the interests of public health and morality it is to be hoped that England will soon follow the example of other countries, and that the public exhibitions of hypnotism will be forbidden by law.

Pitres fears that even the medical use of hypnotism is likely to do harm in many cases, and records instances in which the disappearance of one disorder has been followed by the substitution of another. For instance, he hypnotised a young woman for hysterical vomiting, and the suggestions cured it, but in its place appeared a severe headache, and when that was removed by renewed hypnotic suggestion the

vomiting returned. This alternation of neuroses continued in spite of all treatment for months. Pitres also fears that repeated hypnotisation may, by unduly increasing the subject's mental receptivity, render him too suggestible, and credulous for the ordinary transactions of life. There does not, however, seem any ground for this fear if due care is exercised; and the fact that Liébeault has practised hypnotism on a very large scale in a comparatively small town like Nancy for thirty years without causing any accidents, is in itself a strong argument in favour of the safety of the process. But the present writer is by no means prepared to acknowledge that hypnotism is such an absolutely safe procedure as it is assumed to be in some quarters, and he agrees with Bernheim and Pitres that it should never be employed except with the full consent of the patient and his friends, in the presence of witnesses, and with every precaution. It should not be induced more often than is absolutely necessary, and only with a definite therapeutic object in view.

Liébeault, whose testimony in matters of fact is unimpeachable, gives an experience which shows that hypnotic suggestion may originate as well as cure a troublesome complaint[11]. He relates that a child was brought to him suffering from a slight malady which he succeeded in removing by hypnotic suggestion. For some reason he suggested more frequent urination, with the result that in a few days the parents returned in a very disturbed state of mind, saying that a new complaint had developed worse than the former one, and that the child had wetted her bed each night for three nights. Dr. Liébeault hypnotised her again, and suggested the disappearance of the trouble, and the suggestion was efficacious.

The present writer has met with an instance showing that hypnotic suggestion may be distinctly dangerous if wrongfully applied. The patient was a middle-aged, very stout woman, with a weak and dilated heart, and subject to asthma. In addition to these chronic troubles she developed acute bronchitis, and a medical man was called in to attend

[11] *Thérapeutique Suggestive*, p. 298.

her. It happened that he had been using hypnotism with success in his practice, and when he saw the patient struggling for breath he thought to relieve her by hypnotic suggestion. She was easily hypnotised and fell into a profound sleep, during which he suggested relief of the dyspnœa and quiet breathing. Under continued suggestions the respiration gradually became more shallow and quiet, until at last it ceased altogether. Recourse was had to artificial respiration, and in a few minutes the breathing had resumed its former character.

Heidenhain thinks that even a healthy person might be placed in jeopardy if continued suggestions tending to interfere with respiration were made during profound hypnosis (p. 24[6]), and it is easy to understand how the risk is intensified when the breathing is already embarrassed by disease.

Pitres gives a very clear and interesting description of the phenomena of unilateral hypnosis, transfer, metallotherapy, and magneto-therapy which he has observed in the wards of the Bordeaux hospital.

For example, he describes the case of Paule C., a milliner, aged 20, of markedly hysterical temperament, and with complete right hemi-anæsthesia. She is easily hypnotisable by fixation of the eyes, and it is found that if only one eye is fixed she becomes hypnotised only on that side. When the left eye is fixed her left side becomes cataleptic whilst the right remains in the normal condition. If spoken to on the right side she replies in her natural voice that she is awake, and suggestions do not excite hallucinations; whereas, if addressed on her left side she answers in the typical hypnotic voice that she is asleep, and she can be influenced by suggestion. If told that she is in a garden and may pick the flowers, she will, if the suggestion is made in the right ear, look astonished and vexed, and say she is being made game of; but if the same suggestion is whispered into the left ear she will at once stoop and make the gestures of a person gathering flowers. She is not susceptible in her normal state to the action of metals placed in contact with the skin, but when hypnotised she is intensely affected by

them. If, while in a state of unilateral hypnosis, a gold coin be placed against the normal side, no effect is produced, but directly it is brought in contact with the hypnotised side, she exclaims that it is burning her. It is the same in the muscular sphere. If the normal arm be raised it at once falls, whereas the hypnotised one remains in a state of cataleptic rigidity. In her normal state the right side is anæsthetic, but if a magnet be applied to the right forearm it is found that there is almost immediate transference of the condition to the left side, and the right side becomes sensitive. The transference once affected continues until the patient is aroused. This patient, who is one of a number of similar examples, possesses several hypnogenic zones all situated on the left side of the body, and pressure on any one of these at once induces hypnosis. Contact with the magnet causes transference of these zones to corresponding areas on the right side, and the same applies to the waking or hypno-frenatic zones.

According to Babinski and Luys, transference of symptoms may take place not only between the two sides of the patient but also between one subject and another. For example, Babinski found that when he placed two hysterical patients close together, the one affected with left and the other with right hemi-anæsthesia, and passed a magnet over the leg or arm, one of the subjects would become completely anæsthetic whilst the other would completely recover sensation.[12] Similarly with hysterical contractures, aphonia, and paralyses, they can often be transferred from one patient to another by the action of the magnet. Luys has carried this theory of transference to extreme limits, and applies it to subjects who are not hysterical and to conditions which are not merely functional. In the monthly periodical he edits,[13] one reads of cures of paralysis agitans and other intractable diseases by transfer, but his results lack confirmation in other quarters, and Pitres states he has been unable even to reproduce Babinski's experiments. Bernheim attributes all the phenomena of hypnogenic zones, transfer, and

[12] Soc. de psych. physiol., 1886. Soc. de biologie, 1886.
[13] *Revue d'Hypnologie.*

metallo-therapy to suggestion, and states that he has tried in vain to obtain them spontaneously at Nancy. Pitres, however, strenuously maintains that he has always most carefully eliminated the possibility of suggestion in his experiments, and his position as *doyen* of the faculty at Bordeaux, and the careful manner in which his book is written make one feel that it would be presumptuous to doubt the reality of the facts which he adduces, though they are sufficiently startling. It is often asked how it is that these things occur in the hospitals of France, whereas we never see them in those of England. Pitres' answer would undoubtedly be that it is because we do not look for them. Among the hospital patients of our large towns there exists much the same clinical material as one finds in Paris and Bordeaux. The numerous subjects on whom Pitres has experimented and obtained these phenomena are all highly hysterical women with ill-regulated minds and ill-nourished bodies. They are generally born of neurotic parents, and suffer from such hysterical symptoms as aphonia, anæsthesia, reduced field of vision, &c.

Berillon supposes that the phenomena obtainable during hypnosis supply an important key to the localisation of functions in the cortex. He describes cases in which pressure over the left parietal region produced contraction of the muscles on the right side of the body with motor aphasia, whereas pressure over the right parietal region caused contraction of the limbs on the left side without aphasia.[1] Pitres, however, refuses to accept this theory, and demonstrates that compression of other parts, *e.g.*, over the hyoid bone, is followed by similar results, and he attributes them to reflex muscular disturbance. In addition to hypnogenic zones, Pitres finds in a number of subjects on whom he has experimented other zones of a still more curious character. These he terms ideo-genic zones. He describes (p. 311, 3) the case of Eleanore F. She is easily hypnotised by fixation of the eyes, and when hypnotised exhibits several of these zones. Friction of the alæ nasi produces profound sadness;

[1] "Hypnotisme Experimental, la Dualité Cérébrale et l'Indépendence fonctionnelle des deux Hémisphères Cérébraux." Paris, 1884.

she weeps, and exclaims, "I am in great sorrow. My poor mother is very unhappy." Friction over the mastoid process provokes an access of bad temper in which she stamps her feet and cries: "I am sure my mother won't let me go to Pauillac to-morrow." Friction over the temporal region is immediately followed by an outburst of laughter, in which she says: "No, it is too funny! This book is excessively amusing." Friction of the external occipital protuberance causes the patient to assume a threatening expression, and cry, "If I had a revolver I would kill him. The villain!" All these sentiments were apparently revivals of those she had really experienced. She had some time before been greatly chagrined by her mother's refusal to let her go to Pauillac. She had recently been reading an amusing book. She felt indignant with her father because he had abandoned her mother. But these zones were found to exist in other patients, and in all parts of the body. For instance, Théophile S. is a hysterical woman of twenty, and is also easily and profoundly influenced by hypnotism. In a state of catalepsy she exhibits many ideogenic zones. For instance, pressure or friction over the right clavicular region causes her to exclaim, "How hot it is here!" and at the same time she suits the action to the word by unbuttoning her jacket. Friction over the left submammary region induces a wish to sew, and she calls for her handkerchiefs that she may hem them. Friction over the right inguinal region makes her wish to curl her hair; while, if rubbed over the corresponding region of the left side she expresses a wish to write, and calls for pen, ink, and paper.

Friction over the anterior part of the left leg makes her express a wish to read, while over the right arm it causes her to see a bouquet, and to exclaim: "What a beautiful bouquet! please give it to me." And so on through over a score of regions, a friction over each one of which produces a corresponding mental state.

Pitres says that when he first experimented on this girl he formed the impression that she was shamming in order to appear interesting, but when he found that the effects produced were always the same, that they could not

be altered by suggestion, and that contact with a magnet caused the transference of the zones from one side of the body to the corresponding area of the other side, he was forced to acknowledge them as genuine phenomena (3, page 312).

Pitres states that these zones are, as a rule, only operative during hypnosis, but he adduces cases in which they were demonstrable during the waking state, this being especially the case with erotogenic zones. Pitres does not accept the idea that there is a connection between certain skin areas and parts of the cortex, but prefers to suppose that the zones are first developed by auto-suggestion, and that association of ideas is subsequently sufficient to permanently fix them.

Summing up the cases, he writes that studying a phenomenon to-day is the best means of arriving at a conclusion to-morrow, and he is chary of giving explanations of the phenomena he has observed. He tersely defines the three stages of Charcot's grand hypnotisme thus: Lethargy is characterised by neuro-muscular hyper-excitability with general relaxation and psychical inertia. Catalepsy is marked by cataleptic plasticity of the limbs with susceptibility to suggestion by attitude, and depends on spinal automatism. Somnambulism is dependent on cerebral automatism, and is characterised by cutaneo-muscular hyper-excitability.

Bernheim says but little, and Pitres nothing at all, on the subject of the treatment of drunkenness and dipsomania by hypnotic suggestion, but according to many other writers this is the field in which suggestion shows itself most powerful, and is the sphere in which its effect is most strikingly beneficial. Bernheim states that he has cured four or five cases of morphinomania which had resisted other treatment (1, page 228). Berillon finds hypnotic suggestion a valuable reformative agent in the case of vicious children. Auguste Voisin is almost the only observer who credits hypnotism with being useful in the treatment of insanity, and the Commission of Italian alienists and neurologists, who have been thoroughly investigating the subject,

have reported that they find hypnotism inapplicable in cases of true insanity. At the same time they give it their opinion that in dipsomania, and in certain hysterical conditions simulating insanity it is often efficacious.[1]

It will be seen from the above notice that Professor Pitres does not advocate hypnotic treatment except in special cases, but he considers that the question should be studied by medical men, and he advises his students to master its theory and practice in order that they may know how and when to apply it (3, page 415).

[1] Vide paper by Dr. G. Seppelli, translated from the Archivio Italiano in *American Journal of Insanity*, April, 1891.

Abstracts of British and Foreign Journals.

Thyssen on Astasia-Abasia (*Arch. de Neurologie, t.* xxi.).

The combination of symptoms (syndrome) about to be considered is first alluded to in a work by Jaccoud,[1] where it is described as "Ataxia from want of automatic co-ordination." Lebreton[2] evidently alludes to the same condition in a thesis on Hysterical Paralysis, in these words: "It often happens that the patient, when in the recumbent posture, can execute extensive movements with the legs. But so soon as she is ordered to walk, after taking a few faltering steps the legs begin to fail, and eventually give way under the weight of the body; it would appear as though at a given moment the accumulated store of nervous energy had become exhausted." Some fifteen years later the symptom is described by Charcot and Richer[3] as a "special variety of motor feebleness of the legs from want of co-ordination in relation to position in rest and progression." Weir Mitchell[4] describes the same condition under the name Hysterical Motor Ataxia (1885.) Erlenmeyer,[6] Henoch,[7] and Romei[8] also allude to it.

It was, however, Paul Blocq[9] who, in 1888, made the first exhaustive study of the condition, and established its independence. From the consideration of cases which came under his own observation, and of previously recorded cases of similar type, he deduced a new pathological state (type morbide), for which he suggested the name Astasia-Abasia, which has been since more or less generally adopted.

In the same year Charcot[10] again drew attention to the condition, in a girl of 11 years, at the Salpêtrière, and for the first time used the term Astasia-Abasia in describing a case of this affection in a little boy.

More cases were observed and described by Souza-Leite,[11] Paul Berbez,[12] Grasset,[13] Berthet,[14] Salemi Pace,[15] Brunon,[16] and Charcot.[17] Further additions to the literature of the subject were made by Fr. Helfer[18] (a case of Astasia-Abasia following on Influenza); by Ladame,[19] (a case in which the affection was

paroxysmal). Professor Binswanger[20] has more recently contributed a remarkable paper entitled "Ueber psychisch bedingte Stœrungen des Stehen und des Gehen." Finally, we must mention Mœbius' contribution.[21]

The following is a brief account of the author's cases.

Case I. (Jan. 1888.)—A girl of 11 years; epileptic since three years, trouble in walking of same date. Walking became impossible in November, 1889, after an attack of typhoid fever, but recovered partially. When first seen standing and walking were accompanied by marked staggering (without giddiness). On the other hand, the child could always hop, skip, or go on all fours without any difficulty. Examination of the legs when sitting revealed nothing abnormal—no anæsthesia, no inco-ordination. It had been noticed on several previous occasions that after an epileptic seizure there was a decided narrowing of the field of vision, and a marked improvement in walking for a day or two. On February 22nd, a few hours after a seizure, walking was almost natural, the child only staggering, or rather swaying a little, when turning to the right or left. Closing the eyes did not aggravate the unsteadiness. She continued to hop with perfect ease. The patient was subsequently lost sight of.

Case II. (1888.)—A girl of 12½ years, of neuropathic stock. She was seized in 1887 with giddiness, vomiting and headache, accompanied by spinal hyperæsthesia of such severity as to suggest cerebro-spinal meningitis. In July, 1888, her mother noticed disordered movements of the legs when she attempted to make her stand. About the same time she developed convulsive seizures, preceded by a cephalic aura, with tendency to general contracture. In October following, the patient was seized with unconsciousness whenever the dorso-lumbar portion of the back of her couch was removed, or when it was attempted to make her stand up. It sufficed to sit the child up with the back supported, or to lay her flat on her back, for consciousness to return at once. When sitting up and conscious she is able to move her legs without inco-ordination whilst her eyes are open, but with closed eyes no movement of the legs is possible. During a stay at the seaside she has been able to bathe and swim, in the prone position, without losing consciousness. She spends the day in a wheeled chair with treadles, in which she moves about with ease and rapidity. She presents several hysterogenetic areas which are tender on pressure—ovarian, mammary, spinal, facial and vertical. As a result of treatment by douches and isolation her condition began to improve in 1889, and after six months of functional impotence

the child began to walk again, at first with a tottering gait, but eventually without difficulty.

Case III.—Miss G. C., aged 19 years, came to the Salpêtrière on October 28th, 1888. She has a strong neurotic family history. She stated that she had for some time been liable to attacks of weakness (faiblesses) when crossed in any way. Since six months she has suffered from weakness of the legs, worse during the last month, and is unable to stand without support. Since one week choreic movements of the face and right arm have been noted. The lower limbs offer a normal resistance to passive movements of flexion and extension. Muscular power is somewhat diminished on the left side. She leans back in her arm-chair, and cannot sit up without supporting herself with both arms. She cannot sit up unaided, or rise from the sitting posture. She is unable to stand without support, and even then sways backwards and forwards, and from side to side. When standing she throws herself back on the heels, and the upright posture is further interfered with by inco-ordinate movements (mouvements contradictoires) and prevented by the right-sided paralytic chorea. In walking she drags the right foot (typical gait of hysterical hemiplegia). Subsequently the attacks ceased, and the patient was lost sight of.

Case IV.—Male, aged 26 years. After a four years' residence in Tonkin, where he contracted dysentery, he was admitted to hospital on his return in October, 1889, suffering from cramps in the lumbar region. His condition on November 6th was the following: lumbar pain, paresis, dyæsthesia of legs as low as knees; frequent cramps in legs; some incontinence of urine; exaggeration of knee-jerks; epileptoid trepidation.

At the same time walking was becoming affected, and when ordered to walk he would jump about as though executing a dance. In February of the following year walking had become quite impossible; as soon as his feet touch the ground he springs from toe to heel as if he were on springs. In March he had ceased to attempt to walk. In April there was a marked improvement, and in the following month standing and walking had become possible, though still very saltatory; in July the saltatory movements were daily growing less marked. Dr. Brissaud, who had previous charge of this patient, communicated the following particulars respecting him: "The patient, when he first came under M. Charcot's care, was no longer suffering from *Rythmical Saltatory Abasia*. But at an earlier period — in January—he had spasmodic seizures, which, however, were in-

dependent of abasia. When extended the patient would occasionally be seized with rhythmical tremor precisely similar to that which occurred during walking. This tremor, which came on spontaneously at times, and could be provoked by forcible extension of the leg or flexion of the foot, was closely analogous to epileptiform tremor. Sometimes a sudden removal of the bed-clothes sufficed to initiate the tremor in both legs."

In this respect therefore this patient resembled the subjects of saltatory spasm. He was astasic and abasic only because the weight of the body on the soles of the feet was necessary to cause the spasm. As a matter of fact his attitude when standing and during walking showed no evidence of inco-ordination, but was well under control and not interfered with in any way by the tremors. Gradually the saltatory spasm subsided, and at the present time there only remains some rhythmical abasia which will shortly disappear.

After recording eleven cases of the affection M. Blocq goes on to say: "The onset is rather sudden in the majority of cases. After a sudden emotion or slight traumatism the condition comes into existence at once, or more gradually within the space of twenty-four hours. Not rarely at this period it is preceded or accompanied by pains, such as cephalalgia or rachialgia."

In Charcot and Richer's observations (1883) we read as follows: "this condition develops suddenly after an emotion or traumatism." But in connection with a case he demonstrated last year at the Salpêtrière, Charcot observes: "the neurasthenic disorders sometimes develop suddenly in response to some determining cause, such as a mild attack of rheumatism in which the *physical* disturbance is far in excess of the *psychical* (*sic.*); or during convalescence from acute disease attended with marked bodily prostration, *e.g.*, enteric fever or protracted labour; or again, after intoxication by carbonic oxide as in the present instance."

In this last trepidation in walking came on twenty-two days after the intoxication and appears to have been determined by his jolting against a passer-by.

In Romei's case a child of 11 years developed astasia and abasia within twenty-four hours of a fright. Souza-Leite mentions "a small epidemic of Astasia-Abasia" in which three white women, a mulatto, and a negress were affected.

Prof. Henoch has seen it develop slowly in a child of 7 years, from onanism. The patient experienced difficulty in walking, with intermissions for the first eight months, afterwards permanently.

A lady of 27 years, under the care of B. Salemi Pace, was seized suddenly after a walk, the only discoverable predisposing cause being weak health of several years' duration. In Berthell's case—a girl of 23—the affection followed on hysterical attacks. Binswanger's patient—a business man of 55—was seized quite suddenly as he was sitting down to dinner. He recovered after a while, but subsequently the disease re-appeared in an intermittent form. In a second case (æt. 58) by the same observer, the onset was also quite sudden. In his third case the patient, a music master, aged 35, fell down in the street, and on being raised up was astasic and abasic. Overwork is mentioned as a predisposing cause. Ladame mentions the case of a circus rider who felt unwell during a performance, and four days later suddenly lost the power of walking for a few minutes. For the next four years there was no further evidence of astasia-abasia, but for the last twenty years the condition has returned whenever the patient attempted to walk more than a hundred yards. In this case there was a history of privation, unusual fatigue and physical overwork. A girl of ten years observed by Helfer was siezed on attempting to rise from her bed after influenza; she was cured within five months.

In the author's cases the onset has usually been gradual. Of Blocq's eleven cases the onset was sudden in five.

From these data we may conclude that although the onset is sudden in some cases, or attains its full development in the course of twenty-four hours, it is also frequently slow in its evolution, resembling in this the onset of traumatic hysteria.

Persons of all ages appear to be liable to the affection; the majority of the cases belong to the earlier periods of life, but at least three have occurred in elderly persons.

In addition to the cases quoted or related above, in the course of last year five or six adults suffering from the condition have come under observation at the Salpêtrière. Sex and race do not appear to act as predisposing causes.

Hereditary taint is one of the most constant factors in etiology. Nervous diseases in the parents are of frequent occurrence, and rheumatism is also common. As a matter of fact, the majority of those attacked are predisposed to nervous affections, and this is well borne out by the large majority of the cases quoted above.

As regards symptomatology, all observers draw attention to the fact that the trouble concerns exclusively the combined movements involved in standing and walking, which may be

interfered with in varying degree, whilst on the other hand, in the horizontal position, the patient retains full muscular power and complete control over his limbs.

This main fact of the integrity of power and control in the horizontal station, and the consequent non-appreciation of the combined muscular efforts required in standing and walking, justify the use of the term "astasia-abasia."

The several features of the condition are demonstrated by making the patients stand up and walk. In some standing and walking are absolutely impossible; as soon as the patient is put on his legs they give way under him, and he falls to the ground; but the same individual will get along perfectly on all-fours, or hopping, or will swim without difficulty. Such a person when supported on both sides will put forward his legs much in the manner of a child learning to walk (Blocq). In others standing and walking are both possible, but attended with great difficulty.

The subjects of this complaint devise all sorts of methods of progression. Some hop along like magpies or push with their feet the chair on which they are sitting. A remarkable case occurred at the Salpêtrière, in which the patient could execute a stage-walk (marche dramatique à très grands pas), but was unable to walk quietly. In many cases associated hysterical manifestations reveal the origin of the trouble, but its existence as a symptom of organic spinal disease is not impossible.

Professor Binswanger affects surprise at Blocq recognising three forms of the affection, according as the power of standing and walking is abolished, diminished or modified, and considers the number of divisions excessive in view of the small number of cases observed, for Binswanger only admits that three of Blocq's eleven cases come within the terms of Charcot's definition of the malady; the troubles observed in the other cases being attributed by him to anæsthesias and hyperæsthesias. Of this more anon. Grasset, taking count of the quality rather than of the degree of disturbance, describes three types, according as the trouble is due to weakness to inco-ordination or to rhythmical movements (rhythmical choreic type).

Charcot, in his lecture (1889), adopts the following division :—

Abasia. { Paralytic
{ Ataxic { Tremulous,
{ Choreiform,

according, as standing and walking are impossible, or ataxic, or attended by tremor or choreiform movements. This table roughly indicates the chief heads under which the doubtless

numerous clinical varieties of this affection will naturally group themselves (Charcot). Ladame's case already introduces a complication, and necessitates the addition of a sub-division for paroxysmal astasia-abasia. Moreover, Brissaud's case does not come within any of the existing groups. The author suggests the following classification :

Astasia-Abasia. { Paroxysmal / Continuous { Paraplegic / Ataxic { Tremulous or Trepidating, / Choreiform, / Saltatory,

which may have to be further amplified.

In connection with Souza-Leite's observations, Binswanger maintains the necessity of submitting all recorded cases to a searching criticism, and points out the dangers which may arise from describing a disease in terms of its most striking symptom. The author admits that the two cases in question differ somewhat from the types above laid down, but thinks that Binswanger's objection is fairly met by these words of Charcot: "you must not expect to meet in this domain, or in any other indeed, with pure forms or perfect types."

To Blocq and Grasset, amongst others, is due the credit of having differentiated these symptoms of astasia-abasia from associated conditions, and of having demonstrated that these latter are not the cause of the troubles we are here considering.

It is well known that in many cases of perverted sensibility of the lower limbs the gait is in no wise affected. Moreover, it is not easy to see why sensory troubles, when present, should only affect the mechanisms of normal walking, leaving intact the mechanisms involved in other modes of progression. Sensory troubles when they co-exist are therefore to be considered as hysterical manifestations and not the real cause of the abasic phenomena. As regards differential diagnosis : the inco-ördination in tabes dorsalis and Friedreich's disease attends all movements of the lower limbs. The hysterical ataxia of Briquet and Lasègue occurs only when the eyes are closed. In hysterical paraplegias with complete muscular relaxation and impotence the paralysis is equally marked in the recumbent position. The muscular spasms of rhythmical chorea are characterised by their cadence and regularity. In the reflex saltatory convulsion of Bamberger, spasmodic paralysis, exaggerated reflexes and epileptoid trepidation are prominent symptoms.

Charcot and Blocq have put forward to explain the phe-

nomenon an ingenious psychological hypothesis which has been opposed by Binswanger and criticised adversely by Mœbius. The pathogeny of the French authors is based on our knowledge of the way in which acquired movements become organised. The greater part of the centres for combined muscular movements such as standing, walking, running, swimming, the playing of various musical instruments, &c., are localised in the brain and spinal marrow. On their hypothesis the spinal centre contains the "materiel d'execution," and is set going by the corresponding cortical centre, by the "psychological memory," which determines the kind of impulse necessary to produce the required movement. For standing and walking, which are slow of acquisition, Blocq postulates the existence of differentiated cortical cellular groups which are put in relation by special commissural fibres with corresponding groups of cells in the spinal centres. These cortical groups initiate the stimulus in response to which the spinal centres act automatically. These hypotheses have received a certain amount of experimental confirmation, notably from the observation of automatic movements (flying, swimming, &c.), of certain animals after decapitation. Salemi Pace is of opinion that the cord plays a preponderant part in the causation, and in his own case came to the conclusion that there was a peculiar and partial modification of function in the spinal cord characterised by "dynamic and static motor amnesia." The author is inclined to adopt the views of Blocq, who develops Charcot's ideas, the hypothetical nature of which is fully recognised. The several mechanisms concerned in the performance of walking, standing, jumping, &c., probably contain two centres, or differentiated cellular groups, the one cortical, the other spinal, which are connected by commissural fibres. The spinal group, without doubt the more complex of the two, governs automatic unconscious execution of the co-ördinated movements necessary to the accomplishment of each function; whereas the cortical group has the relatively simple duty of the voluntary issuing of orders to initiate, accelerate, slacken, or arrest the activity of the spinal group. In other words, the *psychological* memory of the acts necessary to set going or to check the nervous apparatus are located in the cortical centre, whilst the *organic* memory which presides over and controls all the details of the prescribed movements has its seat in the spinal centre. Hence in each case the question arises whether the disturbing cause of normal function is to be sought in the encephalon or in the spinal cord.

It is commonly known that fright may cause paralysis of the legs; and fright is precisely one of the determining causes of astasia-abasia, which would thus be an emotional paralysis succeeded by an auto-suggestion of motor impotence. An inhibition of the cortical or spinal centres controlling standing and walking, would serve to explain the mechanism of such a process. Blocq comes to the conclusion that the change is purely dynamic, but still is localised in the nervous centres in such a manner as to give rise clinically to symptoms identical with those due to organic lesion of the same area. These very simple and ingenious hypotheses Blocq has been able to verify experimentally by suggestion.

After excluding the cases which present muscular contractions, trepidation and clonic contractions capable of disturbing the functions of standing and walking, together with those in which pain may have prevented movement, Binswanger places the few remaining cases in the large class of "Zwangvorstellungen," or "obsessions," or under the head Hypochondriasis.

The outcome of Binswanger's criticism of the theories of Charcot and Blocq is that he regards astasia-abasia as a state in which the disordered feelings of the organs maintain a hypochondriac preoccupation, or in which well defined causes compel attention to be fixed suddenly and exclusively on an imaginary motor or static impotence.

In order to explain the "obsession," (*hypochondrische vorstellungskreise*) with which these patients are seized, according to his view, this author quotes Spinoza; the manner of thought of these patients appears to be strongly influenced by their melancholic turn of mind which is in turn kept alive by the abnormal state of their viscera. He is unable to see what objections there are to classing "obsession" as a symptom of hysteria, since in both conditions bodily action is powerfully influenced by imagination and *vice versâ*.

The author maintains, however, that a line can be drawn between "emotive paralysis" or "paralysis dependent on idea" which occurs in persons of hysterical diathesis as a result of traumatism, preoccupation, or emotion, on the one hand, and "obsession" pure and simple on the other, which affects quite a different category of neuropathic individuals.

The only point in common between the two states is that in both the disturbance is of a psychopathic order. Nevertheless, without insisting on the considerable clinical divergence in the two conditions, attention may be drawn from a psychological

stand-point, to the essential difference between the mental troubles in the two cases.

Whereas the hypochondriac is "attentive" even to the point of "obsession" the hysteric is essentially absent-minded. The one concentrates all his faculties on his disease, which is the reason why suggestion is powerless in his case; the other takes no heed of his complaint, and is for that reason generally accounted so favourable a subject for treatment by suggestion. Astasia-abasia is an unconscious, obsession a conscious process.

Mœbius clearly recognises the need of distinguishing between the "inability to will to stand" of the hysteric, and the fear of falling of the subject of "obsession." The "I cannot" of the former is in reality "I cannot will to." As showing the effect of "loss of power to will," when Blocq told a hypnotised subject "you have lost the power of walking," he caused a total loss of motor power; but when he said to him "you no longer know how to walk," the loss of power amounted only to inco-ördination. From another point of view a sort of experimental realisation of abasia lends support to Blocq's theory. It was noted by Steiner that after removal of one of the cerebral hemispheres of the dog-fish, the animal swims in a circle. If it is then allowed to pursue this abnormal (abasic) mode of progression for some time, its lower centres become organised in such a way that, after removal of the other hemisphere, the same animal still continues to swim in a circle.

Mœbius justly observes that the hysteric is conscious that he cannot walk without knowing the reason why, whereas the hypochondriac cannot understand why he is afraid to walk. Again agoraphobia may develop concurrently with neurasthenia, and the latter condition is frequently associated with hysteria, so that the two conditions may co-exist in the same person; it might happen, therefore, that after the sudden disappearance of astasia-abasia, agoraphobia which is always more slow to disappear, would persist alone.

[1] Jaccoud.—*Paraplégie et ataxie du mouvement*, page 653, Paris, 1864. [2] Thèse de Paris, 1868. [3] Charcot et Richer.—*Sudi una forma d'impotenza motrice degli arti inferiori per diffetto de coordinazione* (*Medecina contemporanea*, 1883, p. 6, no. 1.) See also Charcot: [4] *Lezioni cliniche dello anno scholestico*, 83-84, relatte del dotr Millotti, Milano, 1885. [5] Weir Mitchell.—*Lect. of diseases of the nervous system especial in women.* (Philadelphia, 1885, p. 39). [6] Erlenmeyer.—*Ueber statische Reflexkrampf*, 1886, Leipzig. [7] Henoch.—*Hystérie des enfants*, Paris, 1885. (Translation.) [8] Dr. Serafino Romei.—*Paraplegia infantile nel solo atto della ambulatione.* (*Gazetta degli ospitali*, no. 76, p. 605.) [9] Paul Blocq.—*Sur une affection caractérisée par de l'astasie et*

de l'abasie, Paris, 1888. *Archives de Neurologie*, no. 43-44. [10] Charcot.—*Leçons du Mardi*, 24 janvier, 1888. [11] Souza Leite.—*Reflexions à propos de certaines maladies nerveuses observées dans la ville de Salvador : faits d'ataxie et d'abasie. Progrès médical*, XVI., Paris, 1888. [12] Paul Berbez. — Gazette *hebdomadaire*, 30 novembre, 1888. [13] J. Grasset.—*Leçons sur un cas d'hystérie mâle avec astasie-abasie.* Montpellier méd., mars, 1889. [14] Berthet.—*Sur un cas d'astasie et d'abasie.* (Lyon méd., juillet, 1889.) [15] Salemi Pace.—*Amnesia parriale spinale. Gazetta Sicula*, Anno IX., p. 182. [16] Brunon.—*Normandie médicale*, 1889. [17] Charcot.—*Leçons du Mardi à la Salpêtrière*, 1888-1889, 5 mars. [18] Fr. Helfer.—Jahrb. CCXXVI., p. 112. *Med. Gesellschafft zu Leipzig.* [19] Ladame.—*Arch. de Neurologie*, XIX., p. 40, 1890. [20] Prof. Dr. Otto Binswanger.—*Berl. klin. Wochenschrift*, 1890, no. 21.—*Aus der psychiatrischen Klinik zu Jena.* [21] Mœbius.—*Ueber Astasie-abasie*, 1889.

W. PASTEUR, M.D.

Current Nerve Anatomy and Physiology. By ALEX HILL, M.D., Master of Downing College, Cambridge.[1]

PERIODICAL.

1. **Journal of Comparative Neurology.** (*Robert Clarke & Co., 63, W. Fourth Street, Cincinnati, U. S. A. Price* $3.00 *per annum*).

Since the last collection of abstracts was published in BRAIN, a new journal, devoted to Comparative Neurology, has made its appearance. It is to be published quarterly, and the Editor, whose work, as shown by the first two numbers, gives an excellent promise for the future, undertakes to supply his readers with lists of current neurological literature, resumés of important papers and synopses of those of less general interest. The titles of the papers which appear in the first two numbers are given below, but as they only reached us when this number of BRAIN was passing through the press it was impossible to abstract their contents.

ANATOMY.

2. **Certain Recent Researches into the Anatomy of the Central Nervous System.** WALDEYER (*Berliner klin. Wochenschr.*, July 13, 1891, p. 691).

It may be interesting if this short summary is translated in extenso.

"The investigations under discussion were opened by the record breaking work of Golgi, in Pavia, and carried further especially by S. Ramón y Cajál in Barcelona and by Kolliker. To these must be added the embryological observations of His,

[1] It is hoped that the retrospect for 1891 may be completed in the Spring Number. The abstracts now given are not necessarily prior to many which will appear in the complete retrospect.

the comparative and histological investigations of G. Retzius in Stockholm, Fr. Nansen in Bergen and Biederman. The following are the chief results:—

1. "The axis cylinders of all nerve fibres are connected at some part of their course with nerve cells. These places can be described as their origins since, embryologically, the axis cylinders sprout out from the cell, and thence extend centrifugally as well centripetally (*His*).

2. "The ending of all axis-cylinder processes (nerve-processes), whether central or peripheral, appears to be by means of the so-called nerve-branches (*S. Ramón y Cajál* and *Kölliker*). These entirely resemble the antler-like (*W. Kühne*) end-branching of muscle-nerves. A certain number of authors assume that the twigs of neighbouring end-branches are immediately connected together in a network, and also that in addition to the cellular origins an anastomotic connection of axis-cylinders is present throughout the central organs (*Golgi* and his pupils, *Martinotti* and *Sala*, on comparative grounds, *Bela Haller, et al.*), while the greater number (*S. Ramón y Cajál, Kölliker, His, Nansen, Retzius*) can nowhere see an anastomotic connection, so that the different end-branches form within the central organs a thick felt work (nerve-felt, neuro-pilema, *His*), their ends, nevertheless, always being free. If this be true, the transfer of stimuli from nerve to nerve must be regarded as actio in distans."

[Attention has not hitherto been called to the nuclei, granules or bi-polar cells which are found upon the end-branches. They are notable features in muscle-plates, in the embryonic substantia Rolandi, in the cortex of the cerebellum and cerebrum. It may be that a long fibre which starts from a nerve cell ends after dividing by connection with "granules." It is also possible that the protoplasmic processes of nerve cells do not form a permanent network but have a certain mobility, forming variable connections along the lines traversed by nerve impulses (*Hill*).

3. "As *Golgi* discovered, the axis-cylinders also bear lateral branches—these have been traced everywhere, especially by *S. Ramón y Cajál* and *Kölliker*. *Ramón* termed these side branches collateral. Quite different, apparently, are those branches which are to be seen on the posterior roots, to which *Ramón* assigns the following relations:—Each posterior (sensory) root fibre on entering the spinal cord splits in a T shape, one branch running up and the other downwards longitudinally in the cord. Collateral branches originate in fairly regular manner from both these longitudinal branches, as well as from the entering root

fibre. They enter the grey substance and there branch and end freely. Such collateral branches spring also from the anterior root fibres, from the other longitudinal root fibres as well as from the nerve fibres of the medulla oblongata (*Kölliker*), the cerebrum, and cerebellum.

4. "Thus a nerve element, a nerve entity, or 'neuron,' as I propose to call it, consists as the results of observation show (if we do not allow the existence of a reticular connection) of the following pieces:—(*a*) a nerve cell, (*b*) the nerve process, (*c*) its collaterals, and (*d*) the end-branching. This simplest form of the neuron appears, in fact, to be exclusively present in the higher invertebrates as investigated by Nansen, G. Retzius, Biedermann.

5. "The neurons arrange themselves according to Golgi's investigations, which are confirmed by all other people, in two forms, or let us rather say sizes, the 'long' and the 'short.' The long ones send their nerve-process either outwards from the central organ to the periphery in the form of the axis-cylinder of motor, secretory or sensory nerve fibres, or as long tracts through the whole central nervous system for the purpose of tying together its distant parts. The short or local neurons, as we can call them, do not send their axis-cylinder processes farther than the grey substance in the neighbourhood of the cells which belong to them. Golgi has started the hypothesis that they have sensory functions, yet this is not at present certain. We must rather consider that we do not yet know their meaning.

6. "The cells of the neurons in higher animals have, in addition to the nerve-process, a greater or smaller number of other processes, which richly branch (Dendribes of *His*; Protoplasmic Processes, *Deiters*). Their meaning is still uncertain. Golgi and his pupils, as well as Nansen, deny that they have a nervous function; rather is their purpose for the nourishment of the cell. As a matter of fact, one often sees them branch for a long distance in the white substance, where they apply themselves to the supporting tissue and the blood vessels. Nansen is, as far as possible, in opposition to Golgi, and assigns to the nerve cells themselves merely a nutritive function. Ramón y Cajál, Kölliker, and the greater number of other investigators hold, on the other hand, that the cells have undoubtedly nervous functions, but deny with more or less assurance a similar meaning to the dendribes.

7. "Also for the neurogleia (*R. Virchow*) have His, Golgi, S. Ramón y Cajál, Kölliker, and M. v. Lenhossék brought many new facts to light. Two kinds of elements must undoubtedly be

recognised, the ependyma-cells and the gleia-cells (spider cells of Jastrowitz). Ramón and Lenhossék derive the latter from the former. These (the ependyma cells) reach in embryos and in lower vertebrata throughout life from the ventricular surface to the pia-surface. So found, for example, Oyarzun recently in the fore-brain of the frog, as recorded by Edinger in a work issued by the senckenbergischen Gesellschaft. All gleia-cells and also the ependyma cells branch but do not anastomose. Whether in addition to these elements, which have the same source of origin as the neurons (the ectoderm) genuine connective tissue elements appear in the central nervous system (as Götte, Duval, Stricker, and Unger and others think) is a question which is variously answered. His thinks that they soon separate themselves."

3. **Sections through the Human Central Nervous System.** KRONTHAL (*Berlin, Speyer and Peters*, 1890, 17 *Photogravure plates*).

Some of the sections are printed without enlargement, others are magnified. They are cut in various planes, and although stained by several different methods, they are all printed in dark blue-black.

4. **Hughes, Nerves of the Human Body.** (*Edinburgh*, 1890. *E. & S. Livingstone*, 10 plates, 4to).

TOPOGRAPHY.

5. **Cranio-cerebral Topography.** ASSAKY (*Clinica Bucureski*, 1890).

6. **Cranio-cerebral Topography.** DEBIERRE (*Gazette Hebdomadaire de Médicine et de Chirurgie*, xxviii. 14, 1891, pp. 159-161).

COMPARATIVE.

7. **Comparative Anatomy of the Human and Simian Brain.** WILDER (*Philos. Soc. of Washington*, April 14, 1890).

8. **The Central Nervous System of Rodents.** HERRICK & TIGHT (*Bulletin of the Scientific Laboratories of Denison University*, vol. v. 19 plates).

9. **Studies in the Topography of the Rodent Brain: Erethizon dorsatus and Geomys bursarius.** HERRICK (*Bulletin Lab. Denison University*, vol. vi., part 1, June, 1891, pp. 26-46)

10. **Morphology of the Avian Brain.** TURNER (*J. of Comp. Neurology* I. pp. 38-39. pl. v.-viii., also pp. 107-133, pls. xiv., xv., xvi., March, 1891).

11. **Topography and Histology of the Brain of Certain Reptiles.** HERRICK (*Journal of Comp. Neurology* I., pp. 14-38, pls. ix. & x., March, 1891).

12. **Contributions to the Comparative Morphology of the Central Nervous System. Topography and Histology**

of the Brain of certain Ganoid Fishes. HERRICK (*J. of Comp. Neurology* II. pp. 149-183. pls. x., xi., xii. & xiii., June, 1891).

13. **Cells of the Cerebro-Spinal and Sub-Cutaneous Ganglia in Myxine glutinosa.** RETZIUS (*Biologische Untersuchungen*, Neue Folge I, mit 13, Abbildungen).

14. **Muscular and Nervous Systems of Dibothriorhynchus benedenii, &c.** CRETY (*Bollettino della Società di Naturalisti di Napoli*, vol. iv. 1890).

15. **Histology of the Nervous System of Hirudineae.** ROHDE (*Sitzungsber. der Kgl. Preussischen Akademie der Wissenschaften zu Berlin*, III., 1891).

16. **The Central Nervous System of Cladocera.** SAMASSA (*Arch. f. Mikrosk. Anat.* xxxviii., 1, pp. 100-142; pls. v., vi., vii.; Sept., 1891).

17. **The Structure of the Nervous Centres in Limulus polyphemus.** VIALLANÈS (*Comptes rendus de l'académie des sciences, Paris*, 1890, Tome cxi.)

18. **The Nervous System of Parmophorus Australis.** BOUTAN (*Arch. de zoologie exper. et générale.* Série II., Tome 8, No. 2, 1890).

19. **Nervous System of certain Species of Diaptomus.** RICHARD (*Bul. de la soc. zoologique de France*, vol. xv., No. 10, 1890).

20. **Further Studies on the Brain of Limulus polyphemus.** PACKARD (*Zool. Anzeiger*, xiv. 361, 1891).

21. **The Nervous System of Crustacea.** RETZIUS (*Biologische Untersuchungen, Neue Folge*, i. Fourteen plates in folio).

22. **The Origin and Development of the Central Nervous System in Limax maximus.** HENCHMAN (*Bull. of the Museum of Comparative Zoology at Harvard College*, Vol. XX., No. 7, December, 1891. With ten plates).

23. **The Development of the Central Nervous System of Blatta germanica.** CHOLODKOVISKY (*Zool. Anzeiger*, xiv. p. 260, April, 1891).

EMBRYOLOGY.

24. **The development of the Human Hind-Brain, from the end of the first to the beginning of the third month. I. The Medulla Oblongata.** HIS (*Abh. der Math. Phys. Classe der K. s. Gesellsch. der Wissensch.*, xvii. (xxix.), *Leipsic, Hirzel*, 1891, pp. 74, pls. 4).

A systematic account of the development of the medulla oblongata, illustrated with 18 woodcuts and 4 lithographs. It is impossible to reduce this paper to an abstract.

25. **Appearance of Cells in the Embryonic Cord.** RAMÓN Y CAJÁL (*Gazeta Sanitaria de Barcelona*, ii. No. 12).

26. **The Myotomes and the Nerves of the back of the Head and Proximal Region of the Trunk in Embryos of Tailless Amphibians.** CHIARUGI (*Arch. ital. de Biol.* xv., ii., pp. 229-291, May, 1891).

MORPHOLOGY.

27. **The Arrangement of the Supra-cerebral Veins in Man, as bearing on Hill's Theory of a Developmental Rotation of the Brain.** BROWNING (*Association of Amer. Naturalists*, September 24th, 1891; *J. of Nervous and Mental Disease* xviii. ii. pp. 711-717. November, 1891).

Evidence in favour of a gliding of the brain and pia upon the dura and brain case derived from the displacement backwards of the posterior supra-cerebral veins.

PHYSIOLOGY: ELECTRIC CURRENTS.

28. **Electro-motor Phenomena in the Brain as expressions of its Activity.** DANILEWSKY (*Centralbl. f. Physiol.*, v. 1, pp. 1-4, April 11, 1891).

Even weak stimulation of a sense organ or of the internal sensory nerve (the Vagus) produces an obvious change in the electro-motor features of the appointed region of the cortex of the brain, usually on the opposite side. Deep morphia or chloroform-narcosis sets it aside. In some cases very complicated negative variations, which last for a couple of seconds, follow assimulation. The electro-motor phenomena of the cortex of one hemisphere can be affected by stimulating the cortex of the opposite hemisphere. The stimulation-processes in the cerebrum which are caused by external stimuli are accompanied by definite electro-motor phenomena.

29. **Mammalian Nervous System: its functions and their Localisation determined by an Electrical Method.** GOTCH and HORSLEY (*Phil. Trans. of the Roy. Soc. of London*, Vol. 182 (October 15, 1891) B. pp. 267-526, plates 29-35).

This magnificent monograph incorporates the substance of the Croonian lecture. It reached us while these abstracts were passing through the press.

30. **The Currents of the Central Nervous System.** CATON (*Centralbl. f. Physiol.*, 1891, pp. 785-786, March 14).

Calling attention to a paper published in the *British Medical Journal*, 1875, ii., p. 278, in which results are recorded similar to those recently published by v. Marxow and Beck. External surface of cortex of cerebrum positive to cut surface. Functional activity accompanied by negative variation.

PHYSIOLOGY.

31. **Phenomena of Movement in the Brain of Leptodora hyalina.** WIEDERSHEIM (*Anat. Anz.*, v. 23, p. 673).

This animal is transparent, and can when narcotised with chloroform be examined for an hour at a time in a condition of immobility.

The œsophageal ganglion or brain properly so called consists of a *pars mobilis* and *partes fixæ*. The former constitutes the anterior third, and consists of a granular mass rich in cells, in which a slow-flowing movement is to be observed, the corpuscular elements presenting changing pictures and vacuoles appearing. The central nerve substance is not fixed in a stiff form, but is capable of active movement.

PSYCHOLOGY.

32. **Guide to Physiological Psychology in Fourteen Lectures.** ZIEHEN (*Jena*, 1891).

33. **Experimental Analysis of Certain Elements of the Sensation of Weight.** CHARPENTIER (*Arch. de Physiol.* iii., 1, p. 122).

CEREBRUM: PHYSIOLOGY.

34. **Ablation of the Cerebral Hemispheres in the Pigeon.** BOECK and BOEUF (*Bull. de la Soc. de Méd. Mentale Belgique*, Dec., 1890).

The animals survived removal of the greater part of the hemispheres for two and a half years. The animal life subsequent to the operation may be divided into three stages. 1. It is very somnolent. 2. It begins to see, but does not feed itself, and is very irritable; in this stage many animals die. 3. The animal gains in weight, drinks when its beak is placed in water. In this stable stage it shows no want of motility, no inco-ordination or loss of balance. It gradually learns to feed itself and to drink, sees and understands what it sees, hears, feels, sleeps at night, chases other pigeons but does not regain sexual instincts.

CEREBRUM: ANOMALY.

35. **Human Cerebrum with a Remarkably Modified Fronto-Parietal Lobe.** TURNER (*J. of A. and P.*, xxv., pp. 327-337).

Fossa of Sylvius open; absence of the Rolandic and præcentral fissures with the transverse convolutions; convolutions antero-posterior, arranged in tiers, having an arcuate disposition in relation to the Sylvan fissure.

ABNORMALITY.

36. **Anatomical Observations on the Brain and Sense-Organs of the Blind Deaf-mute, Laura Bridgman.** DONALDSON (*American Journal of Psychology*, October, 1890).

FORE-BRAIN.

37. **The Relation of the Cerebral to the Olfactory Portion of the Brain.** WILDER (*Assoc. Amer. Anat. Records*, 1890).

CEREBRUM CONVOLUTIONS.

38. **The Sub-frontal Gyre in Man and Apes.** WILDER (*Buffalo Med. and Surgical Journal*, May, 1890).

CEREBRUM CORTEX.

39. **The Cortex of the Cerebrum and Cerebellum.** TARGOWLA

(*Bul. de la societé anatomique de Paris*, V., 6, 1891, pp. 175-176).

40. **Sensibility of the Cerebral Cortex to Chemical Excitation.** GALLERANI AND LUSSANA (*Arch. ital. de Biol.* xv. 3, pp. 396-403, August, 1891).

CORTEX: PHYSIOLOGY.

41. **The Modifications in Excitability of the Cortex induced by Cocain and the nature of the Psychomotor Centres.** BELMONDO (*Lo Sperimentale*, August, 1890).

Cocain only depresses the irritability of the cortex to a certain extent, and B. concludes that it paralyses the sensory elements in the cortex and not the motor.

CORTEX: HISTOLOGY.

42. **Histology of the Cerebral Convolutions of Lower Mammals.** RAMÓN Y CAJÁL (*Gazeta Sanit. Municipal. de Barcelona*, December 15, 1890).

43. **Special Nerve-Cells in the first layer of the Cerebral Convolutions.** RAMÓN Y CAJÁL (*Gazeta Medica Catal., Barcelona*, 1890, vol. xiii.)

CORTEX: CONVOLUTIONS.

44. **Sylvian fissure and island of Reil in the Genus Hylobates.** WALDEYER (*Sitzb. d. kgl. preussischen Akademie der Wissenschaft zu Berlin*, xvi., 1891, pp. 265-267).

CEREBRUM: CONVOLUTIONS.

45. **Origin of the Cerebral Convolutions** (*Continued*). JELGERSMA (*Centralblatt für Nervenheilkunde und Psychiatrie*, XIV., January, 1891).

LOCALIZATION.

46. **Report of Six Lectures on Cerebral Localization, delivered before the Boston Medico-Psychological Society, February and March, 1891.** DONALDSON (From notes by T. L. Bolton, *American Jour. Psychology*, iv. 1, April, 1891).

CORTEX: LOCALISATION.

47. **The Localisation of Taste in the Cortex.** SCHTSCHERBACK (*Centralbl. f. Physiol.* v. 2, pp. 289-298, August 29, 1891).

Gad had concluded that biting, chewing, and swallowing are in the rabbit reflex acts dependent upon the brain-stem, while the formation of the bolus and its backward movement are governed by the cortex. S. attempts to solve two problems: 1. Can these actions be rendered impossible by destruction of any definite part of the cortex? 2. What is the mechanism of the origin of these movements? In all cases in which the power of swallowing at Will is lost, loss of taste is also evident. Injury to an area extending for 2 to 3 mm. in front and behind the line of the coronal suture and vertically from the longitudinal fissure

to the lower edge of the brain causes loss of taste of the opposite side of the tongue. The loss of taste lasts for six days at the longest.

LOCALIZATION: THERMOTAXIC.

48. **Heat-Centres.** BACULO (*Istituto. di Patologico gen. dell' Univ. Napoli*, 1890).

49. **Position and Value of those Lesions of the Brain which cause a rise in Temperature.** WHITE (*J. of Physiol. XII.* 3, pp. 271-278, plate vi., August, 1891).

Further observations regarding the effects upon the body-temperature of limited injuries to several parts of the brain. Injury by a blunt probe. When this is passed into the optic thalamus there is an average rise of rectal temperature of 1° F. When it is passed into the corpus striatum the average rise is 1.9° F. If 103° F. be regarded as the highest normal temperature the max. rise above this is slight (.4° F.) when the optic thalamus is injured, as compared with the rise (1.8° F.) when the corpus striatum is injured.

Injury to the septum pellucidum causes a marked rise of temperature. Injury to the cerebellum causes no rise of temperature. Injury to the posterior part of the cerebral cortex produces a more marked effect than injury to the frontal portion. Lesions of the crus cerebri cause a marked rise.

HIPPOCAMPUS.

50. **Histology of the Hippocampus Major.** SALA (*Zeit. f. wiss. Zool.*, Bd. 52, 1891, Heft 1, pp. 18-45).

51. **Histology of the Fascia Dentata Tarini.** SALA (*Verh. Xten intern. Kongresses zu Berlin*, ii. 1, 1890, pp. 153-154).

CORPUS CALLOSUM.

52. **The development of the Corpus Callosum of the Human Brain.** MARCHAND (*Arch. f. Mikrosk., Anat.*, xxxvii., pp. 298 to 334, 2 plates).

The corpus callosum makes its appearance during the fourth month as a round swelling (1 to 1.5 mm. thick) at the upper end of the lamina terminalis, precisely in front of the foramen of Monro. From this spot the corpus callosum extends progressively backwards. The inner arcuate convolution has by the end of the fifth month the appearance of the fornix. The outer arcuate convolution constitutes the fascia dentata. At the sixth month the corpus callosum is 14 mm. long; genu and rostrum are complete. The relation of the corpus callosum to the lamina terminalis and the prolonged lamina terminalis, which forms the floor of the ventricle of the septum, is described.

53. **Development and Minute Anatomy of the Corpus Callosum.** BLUMENAU (*Arch. f. Mikrosk. Anat.* xxxvii., pp. 1 to 15, 1 plate).

Sagittal sections of embryonic human brains show that the corpus callosum originates within the upper arcuate convolution, not between the upper and lower. Its central portion develops first. The histological investigation was carried out in pig-embryos for the most part. When first formed the upper layer of the corpus callosum contains all the elements which occur in the mesial wall of the hemisphere. Its under surface, especially where it bounds the ventriculus septi pellucidi and lies between the pillars of the fornix, is covered with the grey substance of the upper arcuate convolution. The cortex which covers its upper surface contains fibres which connect the tuber olfactorium with the fascia dentata; its grey substance is continuous with the fasciola cinerea; it contains large well-developed cells.

54. **Development of the Corpus Callosum in the Human Brain.** MARCHAND (*Archiv. f. Mik. Anatomie*, Band 37, 1891, Heft 2).

55. **On the Brains of a Sheep and Cat lacking the Callosum.** WILDER (*Assoc. Amer. Anat., Records*, 1890).

56. **Recent Investigations on the Structure and Relations of the Optic Thalami.** RUSSELL PEMBERTON (*J. of Comp. Neurology*, iii. pp. 135-149, June, 1891).

OPTIC THALAMUS.

57. **The Relation of the Thalamus to the Paracœle, especially in the Apes.** WILDER (*Assoc. of Amer. Anatomists, Records*, 1889).

EPIPHYSIS.

58. **The development of the Epiphysis Cerebri.** HECKSHER (*Copenhagen, Reitzel*, 1890, pp. 82, plates 2, 23 lithographed figures).

Exhaustive account of the literature. Proper observations of the embryos of representatives of each class of vertebrates. Relation of the brain outgrowth to the epidermis especially studied.

CEREBRAL PEDUNCLES.

59. **The Course of the Fibres in the Pes Pedunculi and the Cortical connections of the Corpus geniculatum internum.** ZACHER (*Arch. f. Psych.* xxii., p. 654).

CEREBELLUM.

60. **The Cerebellum and its Functions.** COURMONT (*Paris, Alcan*, 1891, pp. 600).

Material; comparative, pathological, experimental. Collected from many different sources with a view to proving that the cerebellum is an *organe de sensibilité* and endowed with psychic functions.

CEREBELLUM.

61. 1. **Illustration of the Architecture of the Cerebellum.** HERRICK (*J. of Comp. Neurology*, i. pp. 5-14, plates i.-iv., March, 1891).

62. **The Connections of the Cerebellum.** BROSSET (*Lyons*, December, 1890).

63. **Origin and Course of the Cerebellar Peduncles and their Relation to the Rest of the Central Nervous System.** MARCHI (*Florence. Le Monnier.*, 5 plates).

Observations upon fifteen animals in some of which one hemisphere, in others the middle lobe, in others the whole cerebellum was removed.

Method: large pieces four to five days in Müller's fluid, divided into pieces of one cm., which are placed for eight days more in the same fluid, and then in an "osmio-bichromic" mixture (two parts Müller's fluid to one part one per cent. solution of osmic acid), in which they lie until hard enough to make into sections. The unaltered fibres are coloured a clear grey or ash colour, the degenerated medullary sheaths, dark grey or black.

Amongst Marchi's conclusions are the following:—The brachia conjunctiva do not cross completely, but give some fibres to the optic thalamus of the same side; most of their fibres go to Stilling's nucleus of the opposite side. No fibres go either to the optic tract or to the bundle of Reil. The middle peduncles are not solely commissural, but contain fibres which join the grey matter on both sides. The fibres in the posterior peduncle for the opposite olive are both afferent and efferent. The posterior longitudinal bundle and the fillet have a common origin in the cerebellum, chiefly in the middle lobe, they connect the nuclei of the cranial nerves with the cerebellum. The fillet connects the cerebellum with the pons, corpora quadrigemina, and probably with the corpus striatum. The posterior longitudinal bundle joins the fillet about the level of the olive, and both go into the antero-lateral tracts, and probably are thus connected directly with the anterior horn and indirectly with anterior roots. The origin of all these peduncles is spread over the whole grey matter, but the brachia are connected chiefly with the nucleus dentatus, the middle peduncles with the vermis.

64. **The Fossa Vermiana in Primates.** MORSELLI (*Archivio di psichiatria*, Vol. VI., Fasc. iii., iv., 1890).

CEREBELLUM: HISTOLOGY.

65. **Certain Bi-polar Elements of the Cerebellum and new facts with regard to the Evolution of the Cerebellar Fibres.** RAMÓN Y CAJÃL (*Intern. Monatsschr* ii., pp. 445-468, 1890).

Fœtal mammalian brains investigated with Golgi's method. The nuclei which in the fœtal or new-born brain lie immediately

beneath the pia are divisible into two layers. The superficial layer consists of spherical epitheloid cells with a short process directed towards the surface; the deep layer consists of bi-polar cells, the long axes of which are placed parallel to the surface; the finer of the two processes is to be regarded as the axis-cylinder, it appears to end freely. Peculiar spindle-shaped cells, the long axes of which are vertical to the surface, are to be found in the molecular layer, their axis-cylinder processes pass outwards and join the fibres which lie in the deeper part of the superficial nuclear layer almost at right angles. Two stages are traced in the formation of the cells of Purkinje. 1st, the formation and ramification of their protoplasmic processes; 2nd, their reabsorption or retreat. The fibres connected with each cell of Purkinje form a plexus around its main ascending branch "*l'aborisation ou plexus grimpant.*"

Medulla Oblongata.

66. **The Outer Nucleus of the Funiculus Cuneatus in the Medulla Oblongata.** Blumenau (*Neurol. Centralbl.*, x., 8, April 15, 1891).

Lockhart Clarke described "inner and outer restiform nuclei." The division is usually overlooked or the outer nucleus is described as inconstant (Obersteiner). B. investigated the topography of this nucleus in adult and embryonic brains. It appears at the level in the medulla oblongata at which arcuate fibres begin to pass from the direct lateral cerebellar tract backwards to the inferior end of the restiform body. Only the inner nucleus is to be found lower in the medulla, but even this presents isolated cells which, by their size and form, are judged to belong to the outer nucleus. At first scattered about, they then pass to the periphery, and collect into little groups which lie between the nucleus funiculi gracilis and nucleus funiculi cuneatus or between the latter and the substantia Rolandi. Similar cells are to be observed in the funiculus gracilis, especially in its outer part. The division between inner and outer nuclei is never complete. At first the cells of the outer nucleus are separated by fibres, but afterwards the nucleus becomes very uniform. The cells are multipolar, vesicular, and contain a well-developed nucleus with a nucleolus. Their long diameter equals 50-80 μ, while the cells of the inner nucleus are not usually more than 25-40 μ in diameter. They have a notable resemblance to the cells of Clarke's column. In anatomical situation, too, they seem to belong to this column which elsewhere has a tendency to throw off a detached piece into the midst of the posterior column. The outer nucleus has a considerable size at levels from which the inner has disappeared. On the lateral and ventral sides the nucleus is bounded by a half ring of fibres of the cuneate fascicle which separate it from the restiform body. Ventralwards a layer of grey matter of varying thickness sinks between the

cuneate fascicle and the ascending trigeminal root. The upper end of the nucleus reaches to the point of exit of the most posterior auditory fibres. Then follows an account of the several views held as to the destination of the fibres of the cuneate fasciculus. B. believes that many sets of fibres connect the nuclei of the posterior column with the restiform body. He was unable to determine whether the fibres originate in the large cells, but saw the axis-cylinder processes of the large cells of the inner cuneate nucleus passing towards the outer margin of the fasciculus.

SPINAL CORD: DEVELOPMENT.

67. **The Development of the Posterior Fissure and of the Central Canal of the Spinal Cord.** ROBINSON (*Studies in Anatomy from the Anat. Depart. of Owens College*, i. pp. 67-103, pls. ii., iii., 1891).

Observations upon rats and mice. Careful measurements of size at different periods. In the earlier stages the canal increases in size simultaneously with the growth of the other constituents of the cord. After this it diminishes in dorso-ventral diameter; as this diminution commences before the posterior columns have overlaid the cord, it is not due to their pressure; nor is it due to fusion of the lateral walls of the canal. The conclusion of His that an axis-cylinder is the outgrown process of a nerve-cell, and extends from its parent-cell to the end organ or to some other cell confirmed. The posterior columns consist, at least in the early stages, principally of posterior root-fibres. There is no posterior fissure in the proper sense of the term; the tissue lying between the posterior columns is a modified portion of the original cellular wall of the central canal.

SPINAL CORD: COMPARATIVE.

68. **The arrangement of Fibres in the Spinal Cord.** SCHAFFER (*Arch. f. Mikrosk. Anat.* xxxviii., pp. 157-176, plate ix., Sept., 1891).

Investigation of the arrangement of the fibres in blind-worm, grass-snake, tortoise, and lizard; rabbit, bat, and cat. Among other results Schaffer proves that fibres from both sides of the posterior horn go directly through the anterior commissure into the opposite anterior column. Fibres also go from the lateral column into the opposite anterior column. In the snake, fibres from the mesial side of the posterior root pass directly into the anterior column of the opposite side, but it is not certain whether the connection with the root is direct in the blind-worm.

SPINAL CORD: PHYSIOLOGY.

69. **Symptomatology of Total Transverse Lesions of the Spinal Cord.** BASTIAN (*Medico-Chir. Trans.*, lxxiii., pp. 151-217, 1890).

This paper was omitted from the *Abstracts* at the time of its publication as treating of the pathology of the nervous system.

It should, however, find a place in the record of the anatomy and physiology of the system. It is a protest against considering that it is proved for Man that total transverse lesion of the cord is followed by exaggeration of the reflexes in the region below the lesion, after the effects of shock have passed off.

SPINAL CORD: CONDUCTION.

70. **Afferent Routes in Spinal Cord studied by Degeneration.** ODDI AND ROSSI (*Arch. ital. de Biol.*, xv., ii., p. 203, May, 1891).

SPINAL CORD: NERVE ROOTS.

71. **The influence of the Posterior Roots upon the excitability of the Anterior ones.** BELMODO AND ODDI (*Rivista sperimentali di Freniatria*, xvi., 3).

When the posterior roots are cut or paralysed by cocain, the irritability of the motor roots falls. After section of the posterior roots a short stage of increased irritability follows, due to the effect of the section. In the same way stimulation of the central stump prevents the diminution of irritability. This influence is not affected by cutting across the medulla oblongata. The observers, therefore, conclude that stimuli are constantly reaching the central nervous system from the periphery and streaming across into the motor roots.

SPINAL CORD: HISTOLOGY.

72. **The Histology of the Neurogleia and Nerve-substance of the Spinal Cord.** LAVDOWSKY (*Arch. f. Mikrosk. Anat.*, xxxviii., 2, pp. 264-301, plates xiv.-xviii., Oct., 1891).

SPINAL CORD: HISTOLOGY.

73. **The collateral Fibres of the White Substance of the Cord of Batrachian Larvæ.** RAMÓN Y CAJÁL (*Gazeta Sanataria de Barcelona*, October 10, 1890.

SPINAL CORD: MENINGES.

74. **Connection of the Spinal Cord with the Pia Mater.** ASPLUND (*Nordiskt Medicenskt Arkiv.* XXII., Nov. 4, 1890).

CRANIAL NERVES.

75. **The First Appearance of the Cranial Nerves in the Cat.** MARTIN (*Oesterreichische Monatschrift für Tierheilkunde*, xv., September, 1890.

CRANIAL NERVES: I.

76. **The first development of the Olfactory Nerves.** KÖLLIKER (*Sitzungsb. d. phys. med. Ges. zu Würzburg*, 8 and 9, 1890).

The olfactory nerves do not, as hitherto believed, originate from the olfactory bulb, but (as taught by His) they arise in the epithelium of the olfactory region, run centripetally in the direction of the olfactory lobe, and form a secondary connection with this. The fibres of the olfactory nerve are equivalent to groups of nerve cells, and those fibres which possess a number of nuclei are a complex of nerve cells.

77. **First Phases of development of the Cranial Nerves in Mammals and in particular of the Olfactory Nerve.** CHIARUGI (*Arch. ital. de Biol.* xv. 3, pp. 418-464, August, 1891; also *Monitore Zool. ital.* ii. 3, with plates).

C. concludes that it is useless to look for the primitive origin of the cephalic and spinal ganglia in the "intermediate groove and ridge" (Zwischenrinne und Zwischenstrang) of *His*, although this fold certainly exists. It is not due to artificial folding. *Contra His* the olfactive and auditory fossæ cannot be derived from the intermediate groove. On the other hand C. does not agree with Beard that the cephalic ganglia arise from the ectoderm independently of the medullary fold, but thinks that they proliferate from its edges. C. describes the olfactory nerve as originating with a conical base from the ventral side of the wall of the forebrain before the appearance of any trace of an olfactory lobe. After a short course it applies itself to the olfactory fossa. It is purely cellular and may be properly called the "olfactory ganglion." In this, again, C. differs from *His* who believes that the olfactory ganglion develops in immediate connection with and at the expense of the olfactory plaque, being therefore at a certain stage unconnected with the brain.

78. **The Olfactory Lobes of Fulmarus glacialis.** KLINCKOWSTROM (*Biologiska Foreninges Forhindingar*, iii. 1, 2, Stockholm, 1890-91).

79. **The partial occlusion of the Olfactory lobe in the Canidae** Fish (*Amer. Monthly Microsc. J.*, xii. 3, pp. 49-52, plate, March, 1891).

The olfactory ventricle is closed by an ingrowth of neurogleia. In some wild as well as in domesticated dogs the cavity of the crus is completely closed, the bulb only partially so. Acuteness of smell cannot be therefore essentially dependent upon the relative size of the rhinocoele.

80. **Origin and Termination of the Olfactory Nervous Fibres.** RAMÓN Y CAJÁL (*Gazeta Sanit. Municipal. de Barcelona*).

CRANIAL NERVES: II.

81. **The Course of the Fibres in the Optic Nerves.** HEBOLD (*Neurol. Centralbl.* x. 6, pp. 167-169, March 15, 1891).

Conclusion from pathological observations, that in each optic nerve fibres of the tract of both sides course in closed bundles. The uncrossed bundle lies throughout on the outer margin of the optic nerve, chiasma and tract. The crossed bundle is central in the nerve, ventral in the tract.

82. **Vestiges of Epithelium on the Optic Nerve and on the Retina.** UCKE (*Arch. f. Mikrosk. Anat.*, xxxviii., 1, pp. 24-38, plate ii. September, 1891).

The retinal epithelium is usually described as ending at the

point of entrance of the optic nerve. Ucke shows that it is to be recognised around the optic nerve and also in the optic cups "for a long time." The cavity of the optic nerve is displaced dorsalwards.

83. **The Nervous Elements in the Human Retina.** Dogiel (*Arch. f. Mikrosk. Anat.*, xxxviii. 3, pp. 317-345, plates xix.-xxii., October, 1891.

A continuation of the author's work upon the retina of the submammals, showing that the same conditions obtain in man.

Cranial Nerves: VII.

84. **The Geniculate Ganglion, its Nerves and their Connections.** Penzo (*Ricerche Anatomiche, Atti del Reale Istituto Veneto*, Tomo xxxviii., Series 7, Dispensa 2, 1890-91).

Cranial Nerves: IX., X. & XI.

85. **Origin of the ninth, tenth, and eleventh Cranial Nerves.** Koch (*Nordiskt mediciniskt arkiv.*, xii., No. 11, 1890).

Cranial Nerves: X.

86. **Communicating Branch between Superior and Inferior Laryngeal Nerves.** Howell and Huber (*J. of Physiol.*, xii. 1, pp. 5-12, April, 1891).

In the dog the branch was proved by experiment to be a sensory branch of the superior laryngeal distributed to the trachea and œsophagus, although fused in part of its course with the inferior laryngeal.

Spinal Ganglia.

87. **The Spinal Ganglia.** Muller (*Biolog. foren. forh.*, Bd. 2, 1890).

Reflex.

88. **New Contribution to the Knowledge of the Reflexes.** Erben (*Wiener Med. Wochenshr.*, 1890, p. 879).

E. calls attention to the fact that two-thirds of the large cells of the anterior horn may be destroyed and yet the tendon reflexes increased, not depressed. That exaggeration of the deep reflexes on the non-paralysed side is almost always observable where old hemiplegic lesions with secondary degeneration are present. On the non-paralysed side contractures are also apt to occur. The variable effects of cerebral hæmorrhage upon tendon reflexes, explained as depending upon whether the injury secondarily affects the medulla and spinal cord, especially as regards its blood supply.

Reflex: Anal.

89. **The Anal Reflex: its Physiology and Pathology.** Rossolimo (*Neurol. Centralbl.*, x., 9, pp. 257-259, May 1, 1891).

Localised in the cord of dogs as the fourth pair of sacral roots and up to the level of the third pair in the cord, lower than any skin reflex even that of the soles.

PERIPHERAL NERVES.

90. **Impossibility of Tiring the Nerves of Mammals.** BOWDITCH (*Du Bois Reymond's Arch.*, 1890, p. 505).

Sciatic nerve stimulated and contraction of tibial muscle recorded. Nerve endings paralysed with curari; continued stimulation of the nerve; as the effects of the curari pass off the contractions of the muscle are resumed.

91. **The Limb Plexuses of Mammals.** PATERSON (*Studies in Anatomy from the Anat. Depart. of Owens College*, i. pp. 135-159, 1891. Reprint from *J. of Anat. and Physiol.*, 1887).

92. **Morphology of the Sacral Plexus in Man.** PATERSON (*Studies in Anatomy from the Anat. Depart. of Owens College*, i. pp. 159-167, 1891. Reprint from *J. of Anat. and Physiol.*, 1887.)

93. **Segmental Distribution of Sensory Nerves.** ROSS (*Studies, in Anatomy from the Anat. Depart. of Owens College*, i. pp. 167-197, 1891. Reprint from BRAIN, 1888).

SENSES: SEMI-CIRCULAR CANALS.

94. **Physiology of the Internal Ear.** FANO AND MASINI (*Centralbl. f. Phys.*, 1891, p. 787, March 14).

A number of experiments upon doves. Disturbance of movement does not accord with the direction in space of the canal which is cut. Permanent disturbance follows section of the horizontal canal only. The movements of the head which follow extirpation of a canal depend upon auditory vertigo, and are not due to irritation-processes, but to an abolished function; they cease after destruction of the membranous cochlea. Doves in which both cochlea and canals are destroyed react to sound. Destruction of the cochlea produces disorders of movement, but they are not permanent, and it is quite clear that the canals serve fairly well for audition. Removal of the cochlea does not diminish the forced movements which follow removal of the cerebellum.

SYMPATHETIC SYSTEM.

95. **The Relation of the Nerve Fibres of the Cervical Sympathetic to the Ganglion Cells of the Upper Cervical Ganglion.** LANGENDORFF (*Centralbl. f. Physiol.*, v., 5, pp. 129-131, June 6, 1891).

Certain observations confirming the conclusion of Langley and Dickinson that nicotin poisons the ganglion cells in which the fibres are interrupted before it poisons the fibres. When an animal is killed by bleeding or suffocation, the action of the sympathetic upon the eye can be shown by stimulating the fibres above the ganglion, when the fibres below the ganglion are inactive, owing to the impassable barrier interposed by the dead ganglion cells.

96. **Functional relations of the Cervical Sympathetic with the Epidermis and Glands.** ARLOING (*Arch. de Phys.*, i., p. 160).

Histological changes in the skin and glands of the tip of the nose of the dog and the muzzle of the ox after section of the cervical sympathetic.

97. **The Relation Between the Sympathicus and Head-Ornament of Certain Birds.** JEGOROW (*Du Bois Reymond's Archiv.*, 1890, Suppl., p. 33).

The anatomy and physiology of the vaso-motor nerves of the head ornaments of the turkey and other fowls in which these decorations are capable of erection under the influence of psychical stimuli.

98. **The Sympathetic of Elasmobranch and Osseous Fishes.** CHEVREL (*Thèse. Poitiers, Oudin*, 1890, 8vo, pp. 203).

98* **The Functional Relations of the Sympathetic Chain with Skin and Glands.** ARLOING (*Verhandl. des Xten internat. medic. Kongresses zu Berlin*, 1890, Bd. ii. 2, pp. 9-11; also *J. de Med. veterinaire et Zootechnique, Lyons*, xv. pp. 617-627, 1890).

PILO-MOTOR.

99. **Pilo-motor Nerves.** LANGLEY and SHERRINGTON (*J. of Physiology* xii., 3, pp. 278-292, August, 1891).

The hairs of the monkey, cat and probably all animals in which horripilation occurs under the influence of strong emotion, may be erected by stimulation of nerve-fibres which issue from the spinal cord and pass through the sympathetic nervous system. The effects are mainly unilateral, but in the tail they are bilateral.

GLANDULAR.

99* **Course and Connections of Secretory Fibres Supplying the Sweat Glands of the Feet of the Cat.** LANGLEY (*J. of Physiology*, xii., 4, pp. 347-375, pls. xii. and xiii., September, 1891).

100. **Connection with Nerve Cells of Vaso-motor Nerves for the Feet.** LANGLEY (ditto, pp. 375-378).

BLADDER.

101. **The Motor Nerves of the Bladder.** NAWROCKI and SKABITSCHEWSKY (*Arch. f. Physiol.*, xlviii., 7 and 8, p. 335).

The bladder is supplied by two sets of motor nerves. 1. The upper through the ganglion mesentericum inferius. 2. The sacral nerves within the pelvis. The former come from the spinal cord *via* the fourth and fifth anterior lumbar roots, rami communicantes, lumbar part of the sympathetic chain and nervi mesenterici; the latter by the second and third sacral roots.

SUPRARENAL.

102. **The Termination of Nerve-fibres in the Suprarenal Capsule of Mammals.** FUSARI (*Atti. della R. Accademia delle scienze di Torino*, Vol. XXVI., Dispen. 5, 1890-91).

VASO-MOTOR.

103. **The Vaso-motor Nerves of the Retina and Particularly the Trigeminus.** DOYON (*Arch. de Physiol.*, iii., 3, p. 13).

Dilation of the vessels of the retina on stimulation of the gasserian ganglion.

104. **The Motor Nerves of the Portal Vein.** MALL (*Du Bois Reymond's Archiv.*, 1890, Suppl., p. 57).

105. **The Vasomotor Function of the Spinal Cord.** ADUCCO (*Arch. ital. de Biol.*, xiv., 3, p. 373).

106. **Intracranial Course of the Auricular Vasomotor Nerves.** MORAT (*Arch. de Physiol.*, iii., 1, p. 87).

TROPHIC NERVES.

107. **Trophic Nerves.** ARND (*Archiv. f. Anatomie u. Physiologie, Physiologische Abtheilung*, 1891, p. 54).

HISTOLOGY.

108. **The Structure of the Nerve Cells in the Sympathetic of Amphibia.** SMIRNOW (*Arch. f. Mikr.*, xxxv., p. 407).

Injection of methyl-blue *intra vitam*. The network which invests the cells is a genuine closed network with varicose fibrils. The spinal fibre originates in the network and acquires a myelin sheath sometimes at a considerable distance from the cell. The cell-body and its straight fibre stain badly with methyl-blue. The spinal fibre courses peripherally, and contains fibres which enter into connection with various peripheral structures.

109. **The Diffuse Nerve-Network of the Nerve Centres.** GOLGI (*Arch. ital. de Biol.*, xv., iii., pp. 434-463, August, 1891).

A consideration of the ultimate constitution of grey matter in its anatomical, physiological and psychological aspects.

HISTOGENY.

110. **Development of the Ganglion-rudiments in the Human Embryo.** LENHOSSÉK (*Arch. f. Anat. u. Phys.*, Anat. Abtheilung, 1891, p. 1).

HISTOLOGY: FIBRES.

111. **The Optical Relations of Medullated and non-Medullated Nerves.** AMBRONN (*Berichte der königl. sächs Gesellsch. der Wissensch.*, p. 421, 1890).

MYELIN.

112. **Medullated and non-Medullated Nerves.** GAD and HEYMANS (*Archiv f. Anat. und Physiol.*, p. 530, 1890).

An attempt to define myelin chemically. Which is it of all the chemical substances separated from nerves up to the present? Regarding myelin as the substance which gives the "myelin-formation" with water and blackens with osmic acid, the authors conclude that myelin is lecithin in a free state or in loose chemical combination. They distinguish nerve-fibres with myelin-containing medullary sheaths, with or without Schwann's sheath; nerve-fibres with myelin-free medullary sheaths with or without Schwann's sheath, and free axis-cylinders. Except in the lower vertebrates the roots of the spinal nerves contain no myelin-free fibres. It is questionable whether the statement holds good that all myelin-containing nerve fibres which originate in the cerebro-spinal system lose their myelin by passing through sympathetic ganglia.

113. **The termination of Nerves in the Mucous Membrane and Serous Glands of the Tongue of Mammals.** FUSARI and PANASCI (*Arch. ital. de Biol.*, xiv. 3, p. 240, 1 plate).

114. **The Annular Bands of the Nerve-fibre.** JOHANSSON (*Centralbl. f. Physiol.*, v. 11, pp. 299-301, August 29, 1891).

115. **Certain peculiarities of structure of Medullated Nerves.** MARENGHI and VILLA (*Arch. ital. de Biol.*, xv. 3, pp. 404-408, August, 1891).

116. **The structure of the Nerve-fibre.** OWSJANIKOW (*Bull. de l'Acad. imp. des Sciences de St. Petersburg*, i. 4, p. 497).

The effects of treatment with silver-nitrate studied. Nitrate of silver gives rise to artificial products. The transverse striation is limited to the outer surface of the axis-cylinder, and does not affect the primitive fibrillæ. The keratin-network of Ewald and Kühne is not an artifact.

NERVE-ENDINGS.

117. **The Terminal Nerve-plaques in the Tendons of Vertebrates.** CIACCIO (*Arch. ital. de Biol.*, xiv. 1 & 2, p. 31).

PATHOLOGY.

118. **Paralytic Idiocy in Dogs.** GERDES (*Inaug. diss. Berlin*, 1891).

Condition similar to dementia paralytica both in symptoms and histological changes induced by repeated rotations.

CIRCULATION.

119. **Relation of the Arteria Choroidea Anterior to the Posterior Limb of the Internal Capsule.** KOLISKO (*Wien* 1891. *Hölder*).

CIRCULATION: CEREBRUM.

120. **Cerebral Circulation.** BOECK AND VERHOOGEN (*Brussels*, 1890).

1. In asphyxia the amount of blood circulating in the brain is everywhere increased owing to the active dilation of its vessels. 2. Injection of sulphuric ether raises the general blood pressure, but increases the amount of blood circulating in the brain in still greater proportion. 3. Intravenous injection of morphia renders the cortex anæmic and the base of the brain hyperæmic.

121. **Influence of Attitude on Cerebral Anæmia.** RICHET (*C. R. Soc. de Biol.*, Jan. 17th, 1891, p. 35).

If a large artery of a dog is cut while the animal is held in an upright position, respiration ceases in less than half a minute. It is prolonged by lowering the head.

BRAIN-WEIGHT.

122. **The Brain-weight of certain Animals.** MIES (*Verhandlungen der Gesellschaft deutscher Naturforscher und Aerzte, 63. Versammlung zu Bremen, September*, 1890, *Leipzig*, 1891).

Intracranial pressure is always positive. It varies in the dog from 72 to 190 mm. of water. It is increased when the intracranial space is diminished by the introduction of foreign bodies. All the ordinary symptoms of pressure upon the brain are produced by introducing a fluid or an india-rubber bladder between the dura mater and the bone. Brain-anæmia ensues when the intracranial pressure is raised. Brain-pressure is not increased by injecting neutral or ammoniacal salt solution into its blood-vessels (*contra* Adamkiewicz). Local alterations in pressure were made by placing pieces of laminaria within the skull. Death is produced when the skull space is curtailed by more than $\frac{1}{19}$ to $\frac{1}{20}$ of its volume (*contra* Adamkiewicz, who sets this figure at $\frac{1}{4}$ to $\frac{1}{6}$).

BRAIN-PRESSURE.

23. **Brain-pressure.** CYBULSKI (*Centralbl. f. Physiol.*, iv., 26, pp. 834-6, March 28, 1891).

METHOD.

124. **Staining of the Axis-cylinder in the Spinal Cord.** SCHMAUS (*Münchener Med. Wochensch.*, 8, 1891).

Rub up 1 gramme of sodic carminate (Carminsaüres Natron) with $\frac{1}{2}$ gramme nitrate of uranium, boil for half an hour in 100 grammes of water and filter when cold. Sections lie in this solution for 15-20 minutes. Tissues must be hardened in Müller's fluid.

125. **Three New Methods for Staining the Medulla and Axis-cylinder by means of Hæmatoxylin.** WOLTERS (*Ztschr. f. Wiss. Mikrosk.*, vii.)

1. Tissues hardened in Müller's fluid dehydrated and embedded in celloidin. Sections placed in a solution of hæmatoxylin 2 parts dissolved in a minimum of absolute alcohol and added to 100 parts 2 per cent. acetic acid. The staining solution is kept at 45° C. The sections are then placed in Müller's fluid and differentiated by the potassic permanganate method. Medullated fibres come out blue black.

2. Sections from tissues hardened in 50 per cent. alcohol saturated with bichromate of potassium and sulphate of copper, dissolved by using 5 or 6 drops of glacial acetic acid to the 100 parts are macerated for 24 hours in a mixture of 2 parts of a 10 per cent. solution of chlorate of vanadium and 8 parts of an 8 per cent. solution of acetate of aluminium; washed in water 10 minutes and placed in the above-mentioned hæmatoxylin solution for 24 hours at 45° C.; placed in 80 per cent. alcohol, acid with hydrochloric acid, until they assume a clear blue-red colour; then washed in weak alcohol. For peripheral nerves this gives a staining of the axis-cylinder. 3. By this latter method the pyramids of the cerebrum are coloured deep blue. Axis-cylinders and gleia-cells are also stained.

126. **Impregnation of the Central Nervous System with Quick Silver.** COX (*Weekbl. van het Nederl. Tydschr. v. Geneesk.*, ii. 15, 1890).

Modification of Golgi's method.

CHEMICAL COMPOSITION.

127. **Influence of Chloride of Sodium upon the Chemical Composition of the Brain.** NOVI (*Arch. ital. de Biol.*, xv. 2, p. 203, May, 1891).